



Network Analyses of the Inventory of Interpersonal Problems-32 and the Associations of its Dimensions with Oppositional Defiant Disorder Dimensions in Emerging Adults

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Abstract

Interpersonal relationship problems are key to Oppositional Defiant Disorder (ODD). The study aimed to examine the types of interpersonal relationship problems, as presented in the Interpersonal Circumplex Model (IPC), with the ODD dimensions (oppositional, negative affect, and antagonistic behavior) proposed by Burke et al. (2010). Emerging adults (N = 194) from the general community completed questionnaires covering the DSM-5 ODD symptoms (in the Current Symptom Scales) and the IPC-based interpersonal relationship problems (in the Inventory of Interpersonal Problems-32; IIP-32). Network analysis results of only the IIP-32 variables using normative scores indicated that too dependent followed by hard to be involved had higher centrality values than the other variables. Also, there were large effect size associations for hard to be sociable with hard to be involved; too caring with too dependent; and too aggressive with hard to be supportive. The network analysis that included both the IIP-32 variables and ODD dimensions indicated a large effect size association for oppositional with IIP-32 too aggressive, and a close to moderate effect size association for negative affect with IIP-32 too aggressive. The theoretical and clinical implications of the findings are discussed.

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Introduction

Interpersonal relationship problems cover failures to form relationships, incompetent social behavior, social withdrawal, social anxiety, and behavior that is noxious to others [1]. In the interpersonal circumplex model [2], interpersonal relationship problems are viewed in terms of eight domains. There is now strong empirical data and theory suggesting that interpersonal

relationship problems are major features of mental and psychological health [3]. One disorder that has interpersonal relationship problems as its core feature is Oppositional Defiant Disorder (ODD) [4]. ODD is also multi-dimensional. Although generally viewed as a childhood disorder, numerous studies have shown that ODD is also relevant to adults [5]. The first aim



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of the current study was to use network analysis (not applied previously) to examine how the eight different interpersonal relationship problem areas in the IPC model (as presented in the Interpersonal Problems-32 [6] are associated with each other. The second aim was to use network analysis to examine how the eight interpersonal relationship problem domains in IPP-32 are associated with the ODD dimensions proposed by proposed by Burke et al [7].

Interpersonal Relationship Problems

In the interpersonal circumplex model [8], interpersonal relationship problems are viewed in terms of two orthogonally related bipolar dimensions of agency (behaviors relevant for negotiating social hierarchies) and communion (behaviors relevant for negotiating social distance). In the circumplex model, eight different interpersonal relationship problem areas have been proposed with respect to the dimensions of agency and communion [9]. These dimensions are domineering/controlling, intrusive/needy, self-sacrificing/overly nurturant, overly accommodating/exploitable, non-assertive, socially inhibited/avoidant, cold/distant, and vindictive/self-centered. According to many childhood and adulthood disorders have interpersonal relationship problems as features of their pathology. It is believed that childhood disorders, such as ODD, may have a particular and especially close association with interpersonal relationship problems.

Oppositional Defiant Disorder

In the DSM-5 (APA, 2013), ODD is described as a pattern of angry/irritable mood, argumentative/defiant behavior, or vindictiveness lasting at least six months exhibited during interaction with at least one individual who is not a sibling. For diagnosis of ODD, DSM-5 [4] has a list of eight symptoms. Structurally, DSM-5 has organized the eight ODD symptoms into three symptom groups: anger/irritable, vindictiveness, and argumentative/defiant behavior. However, this organization has not been universally accepted. [10] found that for both parent and teacher ratings of their children, a different three-factor model with factors for oppositional, negative, and antagonistic behavior was supported.

While ODD is generally considered a child/adolescent disorder, recent findings which applied the same childhood ODD symptoms to adults have reported that they persist into adulthood and that they are associated with functional maladjustments, and other problems and comorbidity, comparable to those found in children and adolescents [11-13]. Consistent with the findings for children, [14] found support for the [7] model, with dimensions for oppositional (temper tantrums, arguing, and defiance), negative affect (anger, touchiness, and spitefulness), and antagonistic behavior (annoying and blaming others) in an adult sample. Past findings for ODD in adults have led some researchers to suggest that although not recognized as an adult disorder, ODD is highly applicable to adults, and is an area worthy of further examination [11,12,13].

Relation between ODD and Interpersonal Relationship Problems

As mentioned earlier, in the DSM-5 [4], ODD is described as a pattern of negative interaction behaviors exhibited during interaction with other children. Relatedly, interpersonal relationship problems cover failures to form relationships, incompetent social behavior, social withdrawal, social anxiety, and behavior that is noxious to others. These descriptions highlight concep-

tual overlaps (in particular problematic interaction) between ODD and interpersonal relationship problems. Consistent with this view, there are empirical data showing that ODD symptoms in children and adolescents are associated with interpersonal relationship problems with parents, teachers, and peers [7,15,16,17,18] and that ODD symptoms in adults are associated with poor quality and quantity of peer, social, romantic, and parental relationships [19,5].

Although these past studies have demonstrated the expected links between ODD and interpersonal relationship problems, there are limitations and omissions in existing findings. Most notably, although both ODD and interpersonal relationship problems are multidimensional, in all past studies both constructs were considered unidimensional. Thus, there is a lack of comprehensive data on the specificity of the associations between different ODD and interpersonal relationship problems dimensions. For this, more studies using multidimensional models of interpersonal relationship problems (such as the IPC) and ODD [14] are needed. In this respect, we wish to argue that network analysis would provide more useful theoretical and clinical information, as explained below.

Network Analysis

One easy way to understand network analysis is to view this approach in relation to the latent variable approach that underlies factor analysis. As related to a construct, factor analysis assumes that an unobservable latent factor gives rise to a range of observable behaviors, or is expressed differently, the set of observable behaviors is caused by the relevant unobservable latent construct. In this respect, as related to interpersonal relationship difficulties, this framework assumes that the observable interpersonal relationship difficulties and problems (for example, the eight factors in the IIP-32) are caused by an unobservable latent factor (conveniently called interpersonal relationship difficulties). In contrast to the latent variable approach, the more recently developed network approach assumes that the interaction of observable interpersonal relationship difficulties and problems (for example, the eight factors in the IIP-32) are the cause for so-called interpersonal relationship difficulties [20].

Empirically, network analysis is used to evaluate network models [20,21]. In network analysis, partial associations (correlations) are estimated controlling for all other variables in the network. The relations are estimated using Markov Random Fields [22], often with regularization. Consequently, a conditional independence structure, revealing only the more important "causal" relations between the variables is produced [20,23]. In a network, the variables are referred to as nodes and the relationships between nodes are called edges. Depending on the research goals, network analysis can be conducted for individual indicators (for example, the IIP-32 items) or the domains in a measure (for example the eight factors in the IIP-32). The results of network analysis can be examined visually and quantitatively. Key quantitative features are "core" or "central" (i.e., important) nodes to the model, and the strength of connections between the nodes [20,24].

Important clinical implications can be derived from network analysis. First, in the latent variable approach, the severity or theoretical importance of the indicators comprising a construct is viewed in terms of their mean scores, in a network, this is reflected by their centralities (which are different from means scores). Thus, the latent variable approach and network ap-

proach could potentially reveal different conclusions about the core indicators [25]. In a network, more central indicators are considered to be more influential. Consequently, intervening in these indicators is expected to produce better treatment outcomes. As such an indicator will be connected with other indicators in the model, improvements in the other indicators will also follow. Given the kinds of novel findings that can be obtained by network analysis over the latent variable approach, it could appear valuable that future studies of the structure of the IIP-32 be explored using network analysis.

Measuring Interpersonal Relationship Problems (Inventory of Interpersonal Problems)

A well-established tool for measuring multidimensional interpersonal relationship problems is the Inventory of Interpersonal Problems [9]. The IIP measures the eight dimensions corresponding to the interpersonal circumplex model. To date, many versions of the IIP have been developed, based on both circumplex and factor analysis approaches. One such version is the factor analysis-based Inventory of Interpersonal Problems-32 (IIP-32 [6], which is used in the current study.

The IIP-32 was developed from the original Inventory of Interpersonal Problems [26] which is arguably one of the most widely used measures of interpersonal relationship behavior problems and difficulties. An Exploratory Factor Analysis (EFA) study of the IIP by [27] supported an eight-factor structure, labeled in terms of interpersonal relationship difficulties that people find 'too hard' to do or do 'too much'; and they are organized under two major dimensions: dominance and affiliation which correspond to IPC agency and communion, respectively. The four subscales for the dominance dimensions are too aggressive (difficulties in controlling one's feelings with other people), hard to be involved (difficulties in developing or maintaining a close personal relationship with another person), hard to be supportive (difficulties in putting the needs of others before those of oneself), and too dependent (difficulties with independence; valuing oneself more in terms of how others see oneself). The four subscales for the affiliation dimension are hard to be sociable (difficulties in being sociable with other people), too open (difficulties in setting a boundary between appropriate and inappropriate self-disclosure), too caring (difficulties in not responding to the needs of others, at the expense of meeting one's own needs), and hard to be assertive (difficulties in asserting in relation to the demands of other people) [27].

With 127 items, the IIP can be considered too long for general clinical and research use [6,28,29]. Consequently, several groups have attempted to develop shorter versions of the IPP [28]. Like its longer counterpart, the development of the various short versions of the IIP has been driven using the circumplex model approach and factor analysis approach [28]. Among others, the factor analysis approach has given rise to two different 32-item versions, one developed by [26] and another developed by [6]. As the current study used the 32-item version developed by [6] IIP-32, more information on this version is provided next.

Using Confirmatory Factor Analysis (CFA), the study by Barkham et al. reported support for this IIP-32 model, with each of the scales being well supported in terms of internal consistency reliability and two months of test-retest reliability. The factor structure and composition of the item in the different factors have also been supported in a more recent EFA study involving

a group of non-clinical Portuguese adults [29]. Additionally, the findings in this study indicated support for the convergent and divergent validities of the factors in this scale. Also, except for overly accommodating, the other scales were associated with a range of psychopathologies. Overall, therefore, based on the findings reported in previous studies, it can be taken that the IIP-32 has sound psychometric properties, and can be a valuable tool for clinical and research use in interpersonal relationship problems. Existing data on the structure of the IIP-32 have all come from factor analyses [6,29]. Considering this, and for the reasons previously presented, it could be valuable to obtain additional and new psychometric data for this measure using network analysis.

Limitations of Existing Findings

Although the studies cited above have demonstrated the expected links between ODD and interpersonal relationship problems, there are limitations and omissions in these studies. First, although both ODD and interpersonal relationship problems are multidimensional, in all past studies they have been considered unidimensional. Thus, there is a lack of data on the specificity of the associations between different ODD and interpersonal relationship problems dimensions. Second, all existing psychometric properties of the IIP-32 have come from the latent variable approaches, in particular CFA. Although these findings are valuable, additional and new psychometric data for this measure can be obtained with network analysis. Third, no study has examined the association between ODD and interpersonal relationship problems in emerging adults. Emerging adulthood is a transitional period in life (between adolescence and adulthood) that is characterized by new and unique life tasks, including the changes in existing relations (for instance with parents), building, maintaining, and challenges involving new interpersonal relationships (such as romantic relations). Thus, it can be expected that those with interpersonal relationship problems will experience more mental and psychological health and adjustment difficulties than the usual developmental adjustment problems associated with emerging adulthood [30]. Therefore, focusing on interpersonal relationship problems in emerging adults will be especially useful.

Aims and Predictions of the Present Study

Given existing limitations, there were two major aims in the current study. Using cross-sectional data, the first aim was to use network analysis (Network Analysis Model 1) to examine the network structure of the eight IIP-32 dimensions (hard to be social, hard to be assertive, being too aggressive, being too caring, hard to be involved, being too dependent, being too open, and hard to be supportive). For this, a network graph was produced and interpreted; and we ascertained the more influential IIP-32 dimensions (node centrality) and associations between the nodes (edge weights). Also, the robustness and stability of the network were examined. The second aim of the study was to use a network analysis approach (Network Analysis Model 2) to examine how the three Burke et al. (2010) ODD dimensions (negative affect, oppositional behavior, and antagonistic behavior) were linked with the different IIP-32 dimensions by examining their edge weights. Age and gender were included in this model to control for their effects. The sample comprised emerging adults from the general Australian community. As this study is exploratory and in the absence of existing data, no predictions were made.

Method

Participants

For both the network analysis models there were 194 emerging adults aged between 18 to 29 years. They were recruited from the state of Victoria, Australia. There were 119 females (mean and SD for age = 20.90 years and 3.05 years, respectively) and 75 males (mean and SD for age = 21.27 years and 2.80 years, respectively). The gender groups did not differ significantly for age ($t[192]=0.84$; $p=.40$). Supplementary Table 1 includes the mean and SD scores for all the variables (except gender) included in network analyses models

In terms of the sample size requirement for a network analysis, the number of participants must exceed the number of estimated parameter variables [31]. In Network Analysis Model 1 which included the IIP-32 dimensions (Network Analysis Model 1), there were eight nodes, and therefore, the total number of estimated parameters in this model was 46 $[(9) + (9 \times 8/2)]$ [32]. In Network Analysis Model 2 which includes age, gender, and the IIP-32 and ODD dimensions there were 13 nodes. Thus, the total number of estimated parameters in this model was 105 $[(14) + (14 \times 13/2)]$. As our sample size ($N = 195$) exceeded the total number of estimated parameters in both models, we inferred that our sample size was adequate for the network analyses conducted in the study.

Measures

All participants completed a questionnaire on demographic information, including age, gender, education, employment and relationship status, and previous diagnosis of ODD. In addition, participants completed the Inventory of Interpersonal Problems-32 [6] and the Current Symptom Scale [33].

Inventory of Interpersonal Problems-32 [6]

The IIP-32, developed from the longer 78 items counterpart, has 32 items assessing eight types of difficulties people experienced in their interpersonal relationships. This includes hard to be social; hard to be assertive; too aggressive; too caring; hard to be involved; too dependent; too open; and hard to be supportive. Each item is rated on a five-point scale, from 0 ("not at all") to 4 ("extremely"), in response to the statement: "How much have you been distressed by this problem?". Thus, higher scores indicate higher scores for the specific subscale. Both normative (indication of inter-individual differences) and ipsative (indication of intraindividual differences) scores can be computed for the IIP-32 [6]. For the current study, we used normative scores to correspond to the normative scores used for the Current Symptom Scale [33]. Cronbach's α values for eight IIP-32 scales ranged from .69 to .85.

Current Symptom Scale [33].

The Current Symptom Scale [33] was used to obtain ratings for the ODD symptoms. These symptoms are the same eight symptoms presented for this disorder in the DSM-IV/DSM-IV-TR and DSM-5. Participants indicate the frequency of symptoms over the previous six months on a four-point Likert scale: 0 = "never or rarely", 1 = "sometimes", 2 = "often", and 3 = "very often". Thus, higher scores represented greater ODD severity. In a recent study involving two independent adult samples that compared six different ODD models proposed for children, the [7] model with three factors showed to be the most optimum [14]. The dimensions in this model were oppositional, negative affect, and antagonistic behavior. In the current study, the CSS

ODD symptoms were scored to yield these three dimensions. The Cronbach's alpha values in the current study were .78, .70, and .76 for negative affect, oppositional behavior, and antagonistic behavior, respectively.

Procedure

Ethics approval for the study was obtained from the University of Ballarat (now renamed Federation University, Australia) Ethics Committee. Participants were recruited from various settings (workplaces, shopping centers, recreational and sporting clubs, and the general community). The procedure was explained to potential participants, and a plain language statement about the study was read out and given to them. Participants wishing to participate in the study were given the survey questionnaires (CSS and IIP-32) together with a prepaid reply envelope. Completed surveys were returned either via mail or in-person to researchers. Over 300 questionnaires were distributed to potential participants with a return rate of 67%. Participants received no compensation for their involvement in the study. A debriefing statement was distributed at the end of the study.

Statistical Analyses

Corresponding to the aims of the current study, two network analyses were conducted (Network Analysis Models 1 and 2). Network Analysis Model 1 included only the eight IIP-32 dimensions. Model 2 included the eight IIP-32 and the three ODD dimensions. To control for age and gender effects, these variables were included in Network Analysis Models 2. Both network analyses were conducted using Jeffreys' Amazing Statistics Program (JASP) version 0.14.1.0 statistical software [34]. For the network analysis, the Least Absolute Shrinkage and Selection Operator or g-lasso was applied [35]. The hyperparameter in the study was set at .5 since it is suggested to produce networks that balance specificity and interpretability with sensitivity [31,36]. Missing data were handled using the "exclude pairwise method."

Network analysis provides a graph which is a visualization that facilitates easier interpretation of the data structure. In this graph, positive relations are indicated in blue and negative relations are indicated in red. Additionally, thicker denser colored lines indicate stronger relationships, and the distance between nodes is indicative of the closeness of the relationship between them (i.e., nodes that are more similar are displayed closer to each other).

Apart from the visualization of the network graph, several statistical parameters are reported for a network analysis. The more common ones include the centrality and edges of the nodes [37]. In general, centrality refers to the relative importance of the individual nodes in the network. A central node is highly connected to other nodes, and its activation can be expected to spread (influence) to other nodes. Although there are several indices of centrality, such as betweenness, closeness, degree or strength, and expected influence [38], our primary focus for evaluating the centrality of the nodes in the current study will be expected influence. Expected influence is the absolute sum of edge weights associated with it, taking into consideration negative nodes. This index developed primarily for psychological networks is less prone to the interpretive challenges present in the other centrality indices [39,40]. An edge weight indicates the correlation or partial correlation between two nodes. For effect sizes of edges, [41] have proposed that

small = .15, moderate = .25, and large = .35. Therefore, the current study used this guideline, with the additional consideration that values $\leq .14$ were negligible. Notwithstanding this, all edges were considered important and worthy of interpretation.

In relation to the stability of the centrality indices, they were examined using case-dropping bootstrapping [22]. In this approach, the stability is examined by establishing if the centrality indices remain the same (or correlation stability coefficient) after re-estimating the network with less cases. For this, the correlation stability coefficient should be at least .5 [22]. The accuracy of edge weights was evaluated using bootstrap 95% non-parametric confidence intervals (CIs), with narrower CIs suggesting a more precise estimation of the edge [22].

Results

Network Analysis Model 1 (IIP-32 dimensions)

Given the aim of Network Analysis Model 1, the findings for this model will focus on the graphical visualization of the IIP-32 network, the centrality and edge weights of the IIP-32 nodes, and the stability and accuracy of the centrality indices and edge weights.

Visualization of the IIP-32 Network. With 8 nodes, the maximum number of edges in this network was 28. However, the EBIC glasso estimation used in the analysis reduced the number of edges that were estimated to 21 (sparsity = .25). **Figure 1** shows a visualization of the network structure for the IIP-32 nodes. With the exception of the edges for too open with hard to be sociable and hard to be assertive; and too aggressive with hard to be assertive, all other edges were positive.

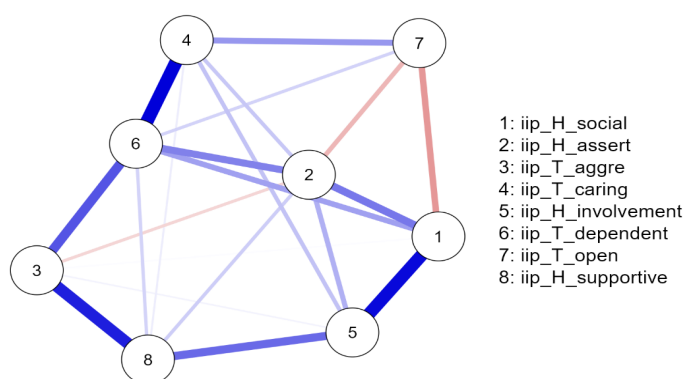


Figure 1: Network Analysis of the IIP-32 Dimensions.

Note: Blue lines represent positive associations and red lines negative associations. The thickness and brightness of an edge indicate the association strength. The layout is based on the Fruchterman–Reingold algorithm that places the nodes with stronger and/or more connections closer together and the most central nodes into the center.

Centrality of the IIP-32 Nodes in the Network.

The stability of the centrality indices (betweenness, closeness, and strength), examined using case-dropping bootstrapping, is shown in Supplementary Figure S2 (JASP, the software used for the network analysis in the study, does not provide this for expected influence). Supplementary Figure S2 shows that for all centrality indices reported, the correlation stability coefficient for the centrality indices remained above .5, as the number of cases dropped to 25% of the original sample. Therefore, the centrality indices were stable [22].

The standardized estimates of the centrality are presented

in **Table 1**. The plots for the centrality measures in terms of z scores are displayed in **Figure 2**. As shown in Table 1, the node with the highest expected influence value (the index used in the study to infer centrality) was too dependent ($z = 1.47$), followed by hard to be involved ($z = .61$). Thus, being too dependent followed by being hard to be involved can be viewed as being more influential than the other nodes in the network. The least central node was too open ($z = -2.01$).

Table 1: Network Analysis Model 1: Centrality Indices of the IIP-32 Dimensions.

Variable	Betweenness	Closeness	Strength	Expected influence
IIP-32 - Hard to be sociable	1.08	0.89	0.49	-0.20
IIP-32 - Hard to be assertive	-1.19	-0.54	0.47	-0.33
IIP-32 - Too aggressive	-0.28	-0.06	-0.66	-0.24
IIP-32 - Too caring	-0.28	0.00	-0.31	0.36
IIP-32 - Hard to be involved	0.63	0.22	0.17	0.61
IIP-32 - Too dependent	1.53	1.72	1.80	1.47
IIP-32 - Too open	-1.19	-1.58	-1.63	-2.01
IIP-32 - Hard to be supportive	-0.28	-0.65	-0.33	0.34

Note. Higher numbers indicate that the variable is more central to the network; the highest value for each symptom group is underlined within each index.

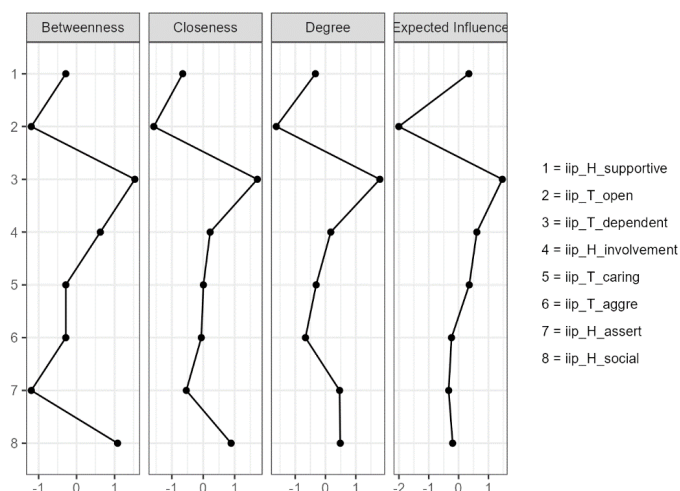


Figure 2: Centrality Plots (Betweenness, Closeness, Degree, and Expected Influence) for the IIP-32 Nodes in the Network Analysis.

Note: Values shown on the x-axis are standardized z-scores.

Edge Weights in the Network

The accuracy of the edge weights estimated using bootstrap 95% non-parametric CIs is shown in Supplementary Figure S3. Our findings showed that the 95% CI of most of the edges included zero and that the CIs around many of the estimated edge weights were relatively narrow. These findings can be interpreted as indicating the accuracy of the edge weights estimated.

Table 2 shows the edge weights matrix between all the IIP-32 nodes in network analysis. As shown in Table 2 (see also Figure 1), the edge weights were positive and of large effect sizes (based on the guidelines adopted for the study for interpreting edge weights network effect sizes: negligible $\leq .14$, small $= \geq 0.15$ to $< .25$, moderate ≥ 0.25 to $< .35$, and large ≥ 0.35) for hard to be sociable with hard to be involved; to caring with too dependent; and too aggressive with hard to be supportive.

They were also positive with a moderate effect size for too aggressive with too dependent; and hard to be involved with hard to be supportive. There were also positive associations with a small effect size for hard to be sociable with hard to be assertive and too dependent; and negative associations, with a small effect size, for hard to be sociable with too open. They were also positive associations with small effect sizes for hard to be assertive with too dependent, and too caring with too open. Although there were positive associations for hard to be assertive with too caring; hard to be involved with hard to be supportive;

too aggressive with hard to be involved; to caring with hard to be involved, too open, and hard to be supportive; and too dependent with too open, and hard to be supportive, all values for all these associations were $< .15$ and therefore, of negligible effect sizes. There was no association between the other ODD and IIP-32 nodes [hard to be sociable with too aggressive and hard to be supportive; too aggressive with too caring and too open; hard to be involved with too dependent and too open; and too open with hard to be supportive.

Table 2: Network Analysis Model 1: Edge Weights Matrix between the IIP-32 Dimensions.

IIP-32 subscales	1	2	3	4	5	6	7	8
IIP-32 - Hard to be sociable (1)	0.00	0.23	0.00	0.00	0.39	0.16	-0.18	0.00
IIP-32 - Hard to be assertive (2)		0.00	-0.07	0.10	0.13	0.21	-0.12	0.08
IIP-32 - Too aggressive (3)			0.00	0.00	0.02	0.28	0.00	0.36
IIP-32 - Too caring (4)				0.00	0.11	0.39	0.18	0.03
IIP-32 - Hard to be involved (5)					0.00	0.00	0.00	0.25
IIP-32 - Too dependent (6)						0.00	0.08	0.08
IIP-32 - Too open (7)							0.00	0.00
IIP-32 - Hard to be supportive (8)								0.00

Network Analysis Models 2

Given the aim of the Network Analysis Model 2, the findings for this model will focus on the results related to the edge weights. This will include the graphical visualization of the combined IIP-32 and ODD network, and edge weights in this network, and the accuracy of the edge weights. Centrality is not relevant in this context. However, for those interested, the standardized estimates of the centrality indices (Supplementary Table S2), the centrality plots (Supplementary Figure S3), and the stability of the centrality indices (Supplementary Figure S4) are provided in the supplementary file but are not discussed further.

Table 3 and Supplementary Figure S5 show the edge weights matrix between all the IIP-32 and ODD nodes, with age and gender as covariates. As shown in Table 3, there was a positive and large effect size edge weight for oppositional with the IIP-32 too aggressive ($r = .45$). There was a close to moderate ($r = .23$) effect size edge weight for negative affect with the IIP-32 too aggressive. Although there were positive associations between ODD antagonistic and ODD negative affect with both the IIP-32 too dependent and the IIP-32 hard to be supportive, they were all negligible effect sizes. In this respect, it is worth noting that the IIP-32 too aggressive (difficulties in controlling one’s feel-

ings with other people) served as a bridge between the ODD nodes and the IIP-32 nodes and that all the ODD nodes were positively associated with each other (see Supplementary Figure S5). There was no association for all the edge weights for the IIP-32 nodes with the ODD nodes (hard to be sociable, hard to be assertive, too caring, hard to be involved and too open with all three ODD dimensions; too aggressive with antagonistic; too dependent with oppositional; and hard to be supportive with oppositional).

Given the large association between ODD oppositional and IIP-too aggressive, we explored if this resulted because of item-overlap across the two measures. Indeed, there are two items (relating to temper and argue) that are almost identical across these measures. We created a new dimension score for IIP-too aggressive without these two items and ran a revised network model with this revised too aggressive domain score, the other seven original IIP dimension scores, and the three ODD dimension scores. In the revised network model, the partial correlation for the revised IIP-too aggressive domain and ODD oppositional domain remain high at $.49$. This finding diminishes the possibility that the high partial correlation between the IIP-too aggressive and ODD oppositional domains in the initial Network Analysis Model 2 resulted from item-overlap. Additionally, the associations between all the other IIP and ODD nodes were

Table 3: Network Analysis Model 2: Weights Matrix between the IIP-32 and ODD Dimensions, Controlling for Gender and Age.

IIP-32 subscales	ODD		
	Oppositional	Antagonistic	Negative Affect
Hard to be sociable	.00	.00	.00
Hard to be assertive	.00	.00	.00
Too aggressive	.45	.00	.23
Too caring	.00	.00	.00
Hard to be involved	.00	.00	.00
Too dependent	.00	.02	.05
Too open	.00	.00	.00
Hard to be supportive	.00	.03	.05

closely comparable to those in the initial Network Analysis Model 2.

The accuracy of the edge weights for Network Analysis model 2, estimated using bootstrap 95% non-parametric CIs is shown in Supplementary Figure S6. Our findings showed that the 95% CI of most of the edges included zero and that the CIs around many of the estimated edge weights were relatively large. These findings can be interpreted as indicating that the edge findings need to be viewed with some cautiously.

Discussion

The current study is the first to use network analysis to examine the structure of the eight IIP-32 nodes. This was examined in a normative-community Australian sample. In Network Analysis 1, it examined the centrality of the IIP-32 nodes in the network, the edge weights for the IIP-32 node pairs, and the stability and accuracy of indices for centrality and edges. In Network Analysis 2, it examined how the IIP-32 and ODD nodes of oppositional, antagonistic behavior, and negative affect were associated with each other.

Network Analysis 1/IIP-32 Network: Symptom Centrality and Associations between Variables

The key findings from the network analysis involving the IIP-32 nodes were that there was no association between hard to be sociable with too aggressive and hard to be supportive; too aggressive with too caring and too open; hard to be involved with too dependent and too open, and too open with hard to be supportive. For symptoms with associations, they were generally positive. The exceptions were too open with hard to be sociable and hard to be assertive, and hard to be assertive with too aggressive. Edges with large effect sizes were hard to be sociable with hard to be involved; too caring with too dependent; and too aggressive with hard to be supportive. Edges with moderate effect sizes were too aggressive with too dependent; and hard to be involved with hard to be supportive. Edges with small effect sizes were hard to be assertive with too dependent, and too caring with too open. There were also associations of negligible effect sizes for hard to be assertive with too caring; hard to be involved with hard to be supportive; too aggressive with hard to be involved; too caring with hard to be involved, too open, and hard to be supportive; and too dependent with too open, and hard to be supportive. Interestingly we found that item overlaps across the IIP-32 and ODD measures did not influence the magnitude of the edge weights. In relation to centrality, too dependent had a relatively high centrality value, and it had many relatively stronger associations with the other IIP-32 variables. The variable with the next highest centrality value was hard to be involved. The least central node was too open. Concerning the reliability of our findings, the study showed sufficient support for edge weights and centrality. Thus, the findings of the study can be interpreted with confidence.

In a network, nodes with high centrality values indicate that they are important and have a strong influence on the network. Conversely, nodes with low centrality values indicate that they are not important and have little influence on the network. Also, the absence of a connection between two nodes implies that they are conditionally independent of each other given the other nodes in the network and they do not influence each other directly. In contrast, the presence of connections between nodes indicated direct associations with each other. Thus, our centrality findings suggest that too dependent, and to a lesser

degree, hard to be involved, are especially important and central for understanding interpersonal relationship problems, and too open is not important for understanding interpersonal relationship problems. Also, concerning edge weights findings, our results indicate no direct associations between hard to be sociable with too aggressive and hard to be supportive; too aggressive with too caring and too open; hard to be involved with too dependent and too open; and too open with hard to be supportive. In contrast, there are direct associations with (1) high effect size for hard to be sociable with hard to be involved; too caring with too dependent; and too aggressive with hard to be supportive; (2) moderate effect size for too aggressive with too dependent; and hard to be involved with hard to be supportive; (3) small effect size for hard to be assertive with too dependent; and too caring with too open; and (4) negligible effect size for hard to be assertive with too caring; hard to be involved with hard to be supportive; too aggressive with hard to be involved; too caring with hard to be involved, too open, and hard to be supportive; and too dependent with too open, and hard to be supportive.

Implications of Network Analysis 1/IIP-32 Network

Our findings for the IIP-32 Network have implications for theory, assessment, intervention, and understanding of interpersonal relationship problems. Firstly, our findings for no associations (hard to be sociable with too aggressive and hard to be supportive; too aggressive with too caring and too open; hard to be involved with too dependent and too open; and too open with hard to be supportive) can be interpreted as indicating that the nodes in these relations are conditionally independent of each other. This is a novel finding and could suggest the need to reconsider the relevance of these interpersonal relationship problem areas in the IPC. This conclusion is further reinforced by our findings that showed negative associations between too open with hard to be sociable and hard to be assertive, and hard to be assertive with too aggressive.

Secondly, the nodes with high centrality values are considered most influential in producing or maintaining conditions under consideration (interpersonal relationship problems in our case), and as our findings showed that the nodes for too dependent followed by hard to be involved had the highest two centrality values, it can be argued that these two interpersonal relation problems areas are more important than the other interpersonal relation problems areas for understanding and assessment of interpersonal relationship problems. Expressed differently, individuals with serious problems related to too dependent and hard to be involved are likely to demonstrate or to be at risk for more serious interpersonal relationship problems. Thus, clinicians may wish to pay special attention to the presence and severity of these problems during the assessment of interpersonal relationship problems. Indeed, our findings suggest that an individual with too dependent problems is likely to show problems in the other interpersonal relation problems areas.

Thirdly, in a network, the nodes with high centrality will have more influence on the network than those will lower centrality values. This means that treatment focusing on nodes with high centrality can be expected to produce better treatment effects not just on these nodes, but also on other nodes with which it is connected. Therefore, this could mean that focusing intervention efforts on too dependent and hard to be involved, rather than the other nodes could maximize treatment effects, and likely cascade to reduce the effects of problems from other

interpersonal relation problems areas. Relatedly, focusing on these interpersonal relationship problem areas may also prevent the onset and development of interpersonal relationship problems as a whole.

Network Analysis 2/IIP-32 Network: Relationships between the IIP-32 and ODD Nodes

The key findings from the network analysis for the combined IIP-32-ODD nodes were (1) large effect size edge weight for oppositional with IIP-32 too aggressive, and close to moderate effect size edge weight for negative affect with IIP-32 too aggressive; (2) negligible effect size edge weight for ODD antagonistic and ODD negative affect with IIP-32 too dependent and IIP-32 hard to be supportive; and (3) no association for the IIP-32 nodes hard to be sociable, hard to be assertive, too caring, hard to be involved and too open with all three ODD dimensions; too aggressive with antagonistic; too dependent with oppositional; and hard to be supportive with oppositional. In a network, the application of *g*-lasso (as used in the current study) will produce the optimal degree of shrinkage, showing only the most important relations. Thus, all edge weights displayed in the network, regardless of effect sizes, can be considered worthy of interpretation. If so, then the associations for oppositional with IIP-32 too aggressive, negative affect with IIP-32 too aggressive, and ODD antagonistic and ODD negative affect with IIP-32 too dependent and IIP-32 hard to be supportive can be considered important.

Our edge weight findings imply that the ODD oppositional and negative affect dimensions are linked to responses to others that reflect being too aggressive (difficulties in controlling one's feelings with other people; domineering/controlling in the IPC); and ODD antagonistic and ODD negative affect are linked to responses to other that reflect being too dependent (difficulties with independence; valuing oneself more in terms of how others see oneself; vindictive/self-centered variables in the IPC) and hard to be supportive (difficulties in putting the needs of others before those of oneself; cold/distant in the IPG). Of these, the associations for oppositional and negative affect with too aggressive may be especially important in the IRP of individuals with ODD. Additionally, as IIP-32 too aggressive served as a bridge between the ODD nodes and the IIP-32 nodes, and all the ODD nodes were positively associated with each other, and many of the IIP-32 nodes were associated with each other, it can be speculated that the preferred area of focus for individuals with ODD who have interpersonal relationship problems is IIP-32 too aggressive (difficulties in controlling one's feelings with other people). The latter is indicative of emotional regulation problems and this has been identified as a major area of concern in ODD [42,43,44]. Corresponding to this it could be proposed that such interventions could focus on emotion regulation [45,46].

Study Limitations and Directions for Further Studies

The results of the study must be interpreted in light of a number of limitations. Firstly, as we used cross-sectional data, the findings cannot be interpreted in terms of a causal relationship. It is more accurate to view our findings as associations, revealing potential causal. Secondly, as a normative-community sample of emerging adults was examined, the findings cannot be directly generalized to other samples, such as specific racial and clinical groups, and other age groups. Thirdly, as we collected data using questionnaires, the findings may not apply to data collected through interviews. Related to this, the use of self-re-

ports could have confounded findings by common method variance. Clearly, more network analysis studies using longitudinal data with data collected using multiple sources and methods, and from different age, racial, and clinical groups are needed. This study has, however, provided new insights into the structure of IIP-32, and how interpersonal relationship problems are related to different ODD dimensions, and also a framework for further studies in this important area.

Conflict of interest statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

References

1. Sroufe A, Duggal S, Weinfield N, Carlson E. Relationships, Development, and Psychopathology. In A. J. Sameroff, M. Lewis, and S. M. Miller (Eds), *Handbook of Developmental Psychopathology* (2nd Ed). New York, Kluwer Academic/Plenum Publishers. 2000.
2. Wiggins JS. *Paradigms of personality assessment*. Guilford Press. 2003.
3. Horowitz LM. *Interpersonal foundations of psychopathology*. American Psychological Association. 2004.
4. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders* (5th ed.). American Psychiatric Publishing. 2013.
5. Johnston OG, Derella OJ, Burke JD. Identification of oppositional defiant disorder in young adult college students. *Journal of Psychopathology and Behavioral Assessment*. 2018; 40: 563-572.
6. Barkham M, Hardy GE, Startup M. The IIP-32: A short version of the Inventory of Interpersonal Problems. *British Journal of Clinical Psychology*. 1996; 35: 21-35.
7. Burke JD, Hipwell AE, Loeber R. Dimensions of oppositional defiant disorder as predictors of depression and conduct disorder in preadolescent girls. *Journal of the American Academy of Child & Adolescent Psychiatry*. 2010; 49: 484-492.
8. Wiggins JS. Agency and communion as conceptual coordinates for the understanding and measurement of interpersonal behavior. In D. Cicchetti & W. M. Grove (Eds.), *Thinking clearly about psychology: Essays in honor of Paul E. Meehl*, Vol. 1. Matters of public interest; Vol. 2. Personality and psychopathology. University of Minnesota Press. 1991; 89-113.
9. Alden LE, Wiggins JS, Pincus AL. Construction of circumplex scales for the Inventory of Interpersonal Problems. *Journal of personality assessment*. 1990; 55: 521-536.
10. Gomez R. Factor structure of parent and teacher ratings of the ODD symptoms for Malaysian primary school children. *Asian Journal of Psychiatry*. 2017; 25: 22-26.
11. Gadow KD, Sprafkin J, Schneider J, Nolan EE, Schwartz J, et al. ODD, ADHD, versus ODD+ ADHD in clinic and community adults. *Journal of Attention Disorders*. 2007; 11: 374-383.
12. Harpold T, Biederman J, Gignac M, Hammerness P, Surman C, et al. Is oppositional defiant disorder a meaningful diagnosis in adults?: Results from a large sample of adults with ADHD. *The Journal of nervous and mental disease*. 2007; 195: 601-605.
13. Reimherr FW, Marchant BK, Olsen JL, Wender PH, Robison RJ. Oppositional defiant disorder in adults with ADHD. *Journal of Attention Disorders*. 2013; 17: 102-113.
14. Gomez R, Stavropoulos V. Oppositional Defiant disorder dimensions: associations with traits of the multidimensional personality model among adults. *Psychiatric Quarterly*. 2019; 90: 777-

- 792.
15. Ding W, Meza J, Lin X, He T, Chen H, et al. Oppositional defiant disorder symptoms and children's feelings of happiness and depression: Mediating roles of interpersonal relationships. *Child Indicators Research*. 2020; 13: 215-235.
 16. Greene RW, Biederman J, Zerwas S, Monuteaux MC, Goring JC, et al. Psychiatric comorbidity, family dysfunction, and social impairment in referred youth with oppositional defiant disorder. *American Journal of Psychiatry*. 2002; 159: 1214-1224.
 17. Harada Y, Satoh Y, Sakuma A, Imai J, Tamaru T, et al. Behavioral and developmental disorders among conduct disorder. *Psychiatry and clinical neurosciences*. 2002; 56: 621-625.
 18. Lin X, Li L, Chi P, Wang Z, Heath MA, et al. Child maltreatment and interpersonal relationship among Chinese children with oppositional defiant disorder. *Child Abuse & Neglect*. 2016; 51: 192-202.
 19. Burke JD, Boylan K, Rowe R, Duku E, Stepp SD, et al. Identifying the irritability dimension of ODD: Application of a modified bifactor model across five large community samples of children. *Journal of Abnormal Psychology*. 2014; 123: 841-851.
 20. Borsboom D, Cramer AO. Network analysis: an integrative approach to the structure of psychopathology. *Annual review of clinical psychology*. 2013; 9: 91-121.
 21. Boschloo L, van Borkulo CD, Rhemtulla M, Keyes KM, Borsboom D, et al. The network structure of symptoms of the diagnostic and statistical manual of mental disorders. *PloS one*. 2015; 10: e0137621.
 22. Epskamp S, Maris G, Waldorp LJ, Borsboom D. Network psychometrics. *The Wiley handbook of psychometric testing: A multidisciplinary reference on survey, scale and test development*. 2018; 953-986.
 23. von Klipstein L, Borsboom D, Arntz A. The exploratory value of cross-sectional partial correlation networks: Predicting relationships between change trajectories in borderline personality disorder. *PloS one*. 2021; 16: e0254496.
 24. Fried EI, Bockting C, Arjadi R, Borsboom D, Amshoff M, et al. From loss to loneliness: The relationship between bereavement and depressive symptoms. *Journal of abnormal psychology*. 2015; 124: 256-265.
 25. Mullarkey MC, Marchetti I, Beevers CG. Using network analysis to identify central symptoms of adolescent depression. *Journal of Clinical Child & Adolescent Psychology*. 2019; 48: 656-668.
 26. Horowitz LM, Alden LE, Wiggins JS, Pincus AL. *Inventory of interpersonal problems manual*. The Psychological Corporation. 2000.
 27. Barkham M, Hardy GE, Startup M. The structure, validity, and clinical relevance of the Inventory of Interpersonal Problems. *British Journal of Medical Psychology*. 1994; 67: 171-185.
 28. Hughes J, Barkham M. Scoping the inventory of interpersonal problems, its derivatives and short forms: 1988–2004. *Clinical Psychology & Psychotherapy: An International Journal of Theory & Practice*. 2005; 12: 475-496.
 29. Faustino B, Vasco AB. Factor Structure and Convergent Validity of the Portuguese version of the Inventory of Interpersonal Problems–32. *Journal of Relationships Research*. 2020; 11.
 30. Arnett JJ. Emerging adulthood: What is it, and what is it good for? *Child development perspectives*. 2004; 1: 68-73.
 31. Epskamp S, Fried EI. A tutorial on regularized partial correlation networks. *Psychological Methods*. 2018; 23: 617-634.
 32. Leme DEDC, Alves EVDC, Lemos VDCO, Fattori A. Network analysis: a multivariate statistical approach for health science research. *Geriatrics, Gerontology and Aging*. 2020; 14: 43-51.
 33. Barkley RA, Murphy KR. *Attention-deficit hyperactivity disorder: A clinical workbook*. Guilford Press. 1998.
 34. JASP Team. *JASP (Version 0.14.1) [Computer software]*. 2020.
 35. Tibshirani R. Regression shrinkage and selection via the lasso. *Journal of the Royal Statistical Society: Series B (Methodological)*. 1996; 58: 267-288.
 36. Foygel R, Drton M. Extended Bayesian Information Criteria for Gaussian Graphical Models. *Advances in Neural Information Processing Systems*. 2010; 23: 2020-2028.
 37. Borgatti SP. Centrality and network flow. *Social Networks*. 2005; 27: 55-71.
 38. Opsahl T, Agneessens F, Skvoretz J. Node centrality in weighted networks: Generalizing degree and shortest paths. *Social Networks*. 2010; 32: 245-251.
 39. Bringmann LF, Elmer T, Epskamp S, Krause RW, Schoch D, et al. What do centrality measures measure in psychological networks? *Journal of Abnormal Psychology*. 2019; 128: 892-903.
 40. Robinaugh DJ, Millner AJ, McNally RJ. Identifying highly influential nodes in the complicated grief network. *Journal of Abnormal Psychology*. 2016; 125: 747-757.
 41. Christensen AP, Golino H. On the equivalency of factor and network loadings. *Behavior research methods*. 2021; 53: 1563-1580.
 42. Burke JD. An affective dimension within oppositional defiant disorder symptoms among boys: personality and psychopathology outcomes into early adulthood. *Journal of Child Psychology and Psychiatry*. 2012; 53: 1176-1183.
 43. Cavanagh M, Quinn D, Duncan D, Graham T, Balbuena L. Oppositional defiant disorder is better conceptualized as a disorder of emotional regulation. *Journal of attention disorders*. 2017; 21: 381-389.
 44. Schoorl J, van Rijn S, de Wied M, Van Goozen S, Swaab H. Emotion regulation difficulties in boys with oppositional defiant disorder/conduct disorder and the relation with comorbid autism traits and attention deficit traits. *PloS one*. 2016; 11: e0159323.
 45. Derella OJ, Johnston OG, Loeber R, Burke JD. CBT-enhanced emotion regulation as a mechanism of improvement for childhood irritability. *Journal of Clinical Child & Adolescent Psychology*. 2019; 48: S146-S154.
 46. Southam-Gerow MA, Kendall PC. Emotion regulation and understanding: Implications for child psychopathology and therapy. *Clinical psychology review*. 2002; 22: 189-222.