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Research paper

Assessing relinquishment of positivity as a central symptom bridging anxiety and depression

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ABSTRACT

Anxiety and depression are often comorbid and chronic disorders. Previous research indicates that positivity relinquishment is a moderator of anxiety and depression, such that only anxious individuals who endorsed relinquishing positivity were also depressed. We sought to extend those findings by conducting three network analyses with self-report measures of anxiety, depression, activity avoidance, and perceived positivity of avoided activities ($N = 104$). We pre-registered our hypothesis for the first two networks that relinquishment of positivity would emerge as a central bridge symptom between anxiety and depressive symptoms. After combining redundant nodes, we estimated three networks and investigated the bridge symptoms in each network. Relinquishment of positivity bridged the symptom clusters in the first network, and avoidance of positivity was found to bridge the two symptom clusters of anxiety and depression in networks two and three. Additionally, an anhedonia circuit was uncovered in all three networks in which loss of interest/worthlessness, loss of energy, and loss of pleasure/pessimism connected to anxiety through relinquishment or avoidance. Our findings suggest that both relinquishment of positivity as well as avoidance of positivity could be potential pathways explaining the development and maintenance of anxiety and depression and should be properly targeted in treatment.

1. Introduction

Anxiety and depression often co-occur, with about three out of every five individuals meeting criteria for generalized anxiety disorder (GAD) also meeting criteria for major depressive disorder (MDD; Jacobson and Newman, 2017; Tyrer and Baldwin, 2006). While some levels of comorbidity are to be expected due to underlying transdiagnostic cognitive and behavioral mechanisms, the incredibly high likelihood of being diagnosed with both GAD and MDD when diagnosed with one or the other is seemingly problematic. It begs the question: are these indeed distinct syndromes and if the answer to the latter is yes, is our understanding of the two syndromes correct?

Some scholars work within the belief that our current diagnostic classification system is hindering research in a way that perpetuates a lack of progress (Fried et al., 2022). Clinical psychology has long relied on a categorical system outlined by the Diagnostic and Statistical Manual (DSM) as it is easy to use, reliable, and conducive to a smooth diagnostic experience. However, the validity of the categories constructed is often called to question as a result of heterogeneous phenotypes and high levels of comorbidity (Fried and Cramer, 2017). The criteria-based structure creates a threshold in which individuals are deemed disordered or healthy, ignoring the heterogeneity of cases that fall in between, despite recent research illustrating MDD as a highly heterogeneous disorder, both within and between persons (Fried and Nesse, 2015; Nemesure et al., 2024).

Various theories have developed ways of combating structural hindrances. Notably, based on basic and translational findings in affective science and neuroscience, a functional classification system, the Research Domain Criteria (RDoC) was developed (Craske, 2012). In contrast to the categorical approach maintained by the DSM (American Psychiatric Association, 2013), RDoC proposes a set of domains: negative valence systems (e.g., anxiety), positive valence systems (e.g. reward processing), cognitive systems (e.g. attention), social processes (e.g. social dominance), sensorimotor (e.g., motor behaviors), and arousal/regulatory systems (e.g., sleep problems; Cuthbert, 2020). In this initiative, psychopathology is viewed as the extremes of these

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domains of normative functioning, in which functionality is no longer adaptive. Using various units of analysis, the model works to identify the underlying mechanisms relevant to psychopathology, rather than solely viewing psychopathology as "pure" disorders and discrete categories. It encourages researchers to frame studies around this set of biological and psychological measurements (Craske, 2012). This perspective can have a positive impact on treatment development, promoting more targeted and integrated treatment approaches that directly affect change at the mechanistic level of dysfunction.

Singular diagnoses do not necessarily indicate singular presentations and examining depression and anxiety together allows for the investigation of shared and unique primary symptoms across depression and anxiety. More specifically, it illuminates potential transdiagnostic positivity biases (Winer and Salem, 2016). Examining disorders on the mechanistic level or assessing the patterns of expression of cognitive/affective processes (i.e., relinquishing or avoiding positivity) via theory-driven hypotheses is a pathway to a more precise understanding of both depression and anxiety as distinct entities, as well as their comorbid expression.

1.1. Reward devaluation as the overlapping mechanism?

Reward devaluation theory (RDT) states that depressed individuals devalue positive information (Winer and Salem, 2016). This is not a mere lack of valuing the positive information (i.e., they have an inability to experience positivity due to some organic abnormality), but is instead an active, resourceful, inhibition. Theorists have posited that this results from positivity being associated with threat or negative outcomes across time (Winer et al., 2011). For example, if hope frequently led to disappointment in the past, the prospect of rewarding information may be processed as dangerous. In this way, it makes it potentially more disquieting than even a sign marked poison.

In a meta-analysis, Winer and Salem (2016) found that when between-subjects were combined at each level of primary symptom, including depression, generalized anxiety, and social anxiety, a significant avoidance of positivity was found only in those whose primary symptom was depression. In addition, depressed individuals demonstrated significant devaluation of reward, differing significantly from those with generalized anxiety as a primary symptom. A preponderance of evidence now supports RDT (Bartoszek and Winer, 2015; Calafiore et al., 2024; Collins et al., 2021; Collins et al., 2023a, 2023b; Gallagher et al., 2022; Gallagher et al., 2023; Jordan et al., 2018; Winer and Salem, 2016).

Moreover, this research found that those endorsing depressive symptoms as their primary were more likely to exhibit an avoidance of positive information than those endorsing differing symptoms (Winer and Salem, 2016). Depressed individuals were the only research group to strongly display devaluation of reward; however, to a lesser extent, individuals exhibiting anxiety also demonstrated the effect, indicating the process by which individuals with depression and anxiety devalue reward is not tantamount, rather they differ significantly. How these processes differ has yet to be examined.

This distinctive reward processing is not necessarily unique to depressed individuals. Using self-report measures, researchers sought to examine the role of anhedonia as a linking factor between the highly comorbid conditions of depression and anxiety (Winer et al., 2017). The findings demonstrated that the relinquishment of positivity as a result of anxiety-driven avoidance moderated the relationship between anxiety and depression. When anxiety-related avoidance resulted in giving up prospective positivity, participants displayed an increase in depressive symptoms. While it is hypothesized from these findings that anxious individuals are willing to give up positive information to avoid experiencing fear or anxiety, much is to be discovered regarding the nuance of this relationship. This needs to be explored further by representing both anxiety and depression not as singular entities, but rather a culmination of their parts, or symptoms.

The network theory of psychopathology provides us a framework to examine the interaction of symptoms that commonly present in tandem within one model (Borsboom et al., 2017). This relies on the notion that a mental disorder is a product of the interaction of its symptoms within a given system. Driven by network theory, thus, the symptoms listed in the DSM-5 do not describe facets manifesting from an internal syndrome (Fried and Cramer, 2017). For example, a depressed presentation is occurring due to the interactivity of symptoms such as depressed mood and anhedonia, but neither symptom is "caused" by depression. That interactivity is the depression. In this way inputting symptoms into a network model can also allow researchers to draw conclusions regarding the connections between anxiety and depression symptoms. Instead of merely looking at how relinquishment of positivity might interact with sum scores of anxiety to predict depression scores, one can instead precisely map out what symptoms are commonly associated with depression or anxiety and what manner of positivity relinquishment inter-relate systematically. In this way, RDT and the network theory of psychopathology can work in tandem to adequately conceptualize this comorbidity, in which the comorbid expression of depression and anxiety is a system of interconnected symptoms and motivational mechanisms, namely those having to do with the avoidance and relinquishment of prospective reward, influencing the development and maintenance of further symptoms and mechanisms. In this sense, avoidance and relinquishment of reward are key factors inhibiting the experience of future positivity, as outlined by Reward Devaluation Theory (Gallagher et al., 2024; Winer and Salem, 2016).

Thus, we sought to extend the findings of Winer et al. (2017) by conducting a network analysis using items within the self-report measures of anxiety, depression, positivity avoidance, and perceived enjoyability of avoided activities. We hypothesized that relinquishment of positivity would emerge as a central bridge symptom between anxiety and depressive symptoms, and that the overarching network would provide a more precise and contextualized picture of these inter-relationships.

2. Methods

2.1. Participants

Participants across the United States were obtained from Amazon's Mechanical Turk (MTurk). Participants ($N = 109$) were pre-selected for heightened psychopathology such that those who received a score of 16 or higher on the Beck Anxiety Inventory met inclusion criteria. Five participants (4.5 %) who provided nonsensical responses to open-ended questions were not included in the study. The sample consisted of 39 men and 65 women ranging 19 to 60 years old ($M = 31.54$; $SD = 9.47$). 66.3 % of the sample identified as White, 6.7 % Black, 16.3 % Asian, 5.8 % Hispanic, and 4.8 % identified as other. All participants provided informed consent. The data used in this study was archival, retrieved from Study 1 of Winer et al. (2017), and was reviewed and approved by the University of Illinois at Chicago Institutional Review Board.

2.2. Materials and measures

2.2.1. Self-report measures

2.2.1.1. Depression. Depression was measured using the Beck Depression Inventory (BDI-II; Beck et al., 1996). This measure consists of 21 items and is scored on a 4-point Likert scale ranging from 0 (e.g. I do not feel sad) to 3 (e.g. I am so sad or unhappy that I can't stand it) with higher scores representing more severe depression. Scores range from 0 to 63, with 0–13 indicating minimal depression, 14–19 indicating mild depression, 20–28 indicating moderate depression, and 29–63 indicating severe depression. Participants in the study had a mean BDI score of 29.02, with a standard deviation of 12.32, indicating that the average

BDI score within the sample fell within limits of severe depression.

2.2.1.2. Anxiety. Anxiety was measured using the Beck Anxiety Inventory (BAI; Fydrich et al., 1992). This measure consists of 21 items and is scored on a 4-point Likert scale ranging from 0 (Not At All) to 3 (Severely – it bothered me a lot) with higher scores representing more severe anxiety. Scores range from 0 to 63, with 0–7 indicating minimal anxiety, 8–15 indicating mild anxiety, 16–25 indicating moderate anxiety, and 26–63 indicating severe anxiety symptoms. Participants in the study had a mean BAI score of 27.85, with a standard deviation of 9.20, indicating that the average BAI score within the sample fell within limits of moderate anxiety.

2.2.1.3. Reward devaluation. Reward devaluation theory is an overarching theory that seeks to conceptualize the tendency for individuals to avoid and inhibit positive information, over and above neutral information (Winer and Salem, 2016). There are various ways of operationalizing this theory. Based on previous research (Winer et al., 2017), the role of RDT in the comorbid expression of depression and anxiety was operationalized using measures of positivity avoidance–the extent to which an individual is avoiding positive experiences as a result of anxiety, and positivity relinquishment–the extent to which an individual is aware of the enjoyment they might experience if they were to engage in that activity. While both constructs endorse an element of RDT, one is measuring behavior and the other is measuring a cognitive process, respectively.

2.2.1.3.1. Positivity relinquishment. To measure the positivity relinquishment or the extent to which individuals were giving up such potential reward, participants were subsequently asked in a self-report item "How enjoyable/interesting would you find these activities to be (if you could do them without experiencing any anxiety)?" The item was rated on a 5-point Likert scale ranging from (a) very slightly to (e) extremely.

2.2.1.3.2. Positivity avoidance. Positivity avoidance was measured using an item that belonged to a set of 4 questions presented to participants. Participants first read the background statement of "People sometimes give up certain enjoyable or interesting activities because these activities are also anxiety provoking." Then, they are asked to think of enjoyable activities that they may be giving up as they are provoking anxiety. Finally, they answer the item measuring positivity avoidance stating "Currently, what percentage of enjoyable/interesting activities do you avoid because they may trigger anxiety?" Responses are scored on a sliding scale from 0 % to 100 %.

2.2.2. Procedure

Items were programmed into Qualtrics software and disseminated via Amazon's MTurk. All prescreened individuals were paid $0.05. Prescreening involved a BAI in which individuals with scores of 16 and above had the option to participate in the study, for which they were compensated an additional $0.60. Participants completed an informed consent, the positivity avoidance and positivity relinquishment items, and the BDI among other items not involved in this study. Lastly, participants provided demographic information and were debriefed.

2.2.3. Statistical analyses

All hypotheses and data analytic plans were pre-registered prior to data analysis: https://aspredicted.org/PLK_64W. All analyses were run in R (v. 4.2.3).

2.2.3.1. Network selection. Following recommendations by Epskamp et al. (2018), we included 14 nodes in each network to ensure reliability in which the number of observations was greater than the possible number of edges in each network. Which BDI and BAI items chosen to be included in the networks was largely based on the work of Jacobson and Newman (2014) in conjunction with Park and Kim (2020). Jacobson and Newman (2014) used items of anxiety and depression measures to assess avoidance mediating depression and anxiety. Using a network approach, Park and Kim (2020) found the BDI items measuring loss of energy, loss of interest, and worthlessness and the BAI items measuring faintness or lightheadedness, feeling of choking, feeling scared, fear of worst happening, nervousness, and unable to relax to be the 10 most central nodes in a network of anxiety and depression symptoms.

Additionally, selecting which items from the self-report positivity and importance relinquishment and avoidance scales to include in the networks was informed by the findings of Winer et al. (2017). The only item that moderated the relationship between anxiety and depression was the one measuring prospective enjoyability of avoided activities; the mere percentage of enjoyable/interesting activities that were avoided or the importance of such activities were not significant moderators. As such, in the first network, this was the only relinquishment item included, and in the second network we included all 4 for comparison. This was slightly adjusted due to poor stability indices, to be elaborated further in subsequent sections, in which the final nodes included in the networks were identical BAI and BDI items, differing only in the first model including positivity avoidance and the second model including positivity relinquishment. See Table 1 for a complete list of nodes in each network.

Table 1
Node names.

Node name	Node description
BDI	
Sadness	I am so sad or unhappy that I can't stand it.
Pessimism	I feel my future is hopeless and will only get worse.
Pleasure	I can't get any pleasure from the things I used to enjoy.
Interest	It's hard to get interested in anything.
Worthlessness	I feel utterly worthless.
Energy	I don't have enough energy to do anything.
BAI	
Relax	Unable to relax.
Worst	Fear of the worst happening.
Scared	Scared.
Sweats	Hot/cold sweats.
Positivity Assessment	
Enj_Relinq	How enjoyable/interesting would you find these activities to be (if you could do them without experiencing any anxiety)?
Perc_Enj_Avoid	Currently, what percentage of enjoyable/interesting activities do you avoid because they may trigger anxiety?

Note. BDI = Beck Depression Inventory, BAI = Beck Anxiety Inventory; BDI node descriptions depicted in this table are the most severe response options.

2.2.3.2. Redundant nodes. Nodes that were highly intercorrelated ($r > 0.50$) and had <25 % of connections with other nodes that were statistically different were combined via the *reduce_net* function. We applied principal component analysis to combine the first principle component of the nodes and utilized the *estimateNetwork* function in the bootnet package to estimate the two networks (Epskamp et al., 2018). BDI items 12 and 14 were combined into one node (loss of interest and worthlessness). Additionally, BDI items 2 and 4 were combined into one node (pessimism and loss of pleasure). These reduced nodes led all three networks to contain 9 nodes in total. Table 1 provides a completed list of all nodes.

2.2.3.3. Centrality indices. We estimated the expected influence (EI) of each node to investigate which nodes were more influential than others in the network. To calculate EI, the model measures each node's sum of edge-weights (Robinaugh et al., 2016), and nodes with high EI have high network influence. An individual node's influence on the nodes directly connected to it and subsequently the influence it has on the nodes it is both directly and indirectly connected to is represented via one-step and two-step EI, respectively.

2.2.3.4. Bridge analysis. Additionally, we were interested in assessing the role of each node in connecting the communities in the networks. The *bridge* function in the *networktools* package measures the bridge nodes by summing the edge-weights of a given node to nodes in different communities, (i.e. a symptom of depression to the symptoms of anxiety; Jones et al., 2021). An individual node's influence on the nodes in another community directly connected to it and subsequently the influence it has on the nodes in another community it is indirectly connected to is represented via one-step and two-step bridge EI, respectively. Nodes with higher EI to other communities may be highly influential to that community.

2.2.3.5. Theoretically based adjustments due to stability indices. As stated, and outlined in our pre-registration, it was originally intended to estimate two networks, both consisting of 14 nodes, in which the first network would include the positivity relinquishment item that has been shown to be influential in the relationship between anxiety and depression (Winer et al., 2017) and the second network would include all 4 items from the positivity relinquishment self report measures. Both networks were to include empirically bound items from the BAI and BDI. As stated in our pre-registration, if the correlation-stability coefficient revealed poor stability indices (CS-coefficient < 0.50), then we would make theoretically based decisions regarding which nodes to include in the network analysis to be adequately powered for our sample size. After estimating the original networks, both networks did indeed reveal CS-coefficients <0.50. Therefore, we shifted the nodes in both networks to include the same BDI and BAI items, with the differentiating piece of the first network would include the positivity relinquishment item and the second network would include the positivity avoidance item.

3. Results

3.1. Descriptive statistics

Table 2 summarizes the descriptive statistics of the collected data prior to combining nodes for redundancy. Following recommendations by Kline (2011) normality was assessed, with skewness and kurtosis being <2. There was no missing data, therefore we did not need to employ multiple imputation using the *mice* package in R.

Table 2
Descriptive statistics.

Variable	*M*	*SD*	*N*	Skewness	Kurtosis
1. EnjRel.	3.900	0.887	104	−0.660	0.295
2. EnjAvoi.	51.110	25.449	104	−0.141	−0.662
3. Worst	1.990	0.887	104	−0.557	−0.370
4. Scared	1.500	0.892	104	0.000	−0.711
5. Relax	2.000	0.824	104	−0.424	−0.460
6. Sweats	1.330	0.918	104	−0.011	−0.917
7. Worth.	1.260	1.005	104	0.217	−1.056
8. Interest	1.310	0.882	104	0.303	−0.545
9. Energy	1.410	0.888	104	0.013	−0.720
10. Sad	1.040	0.709	104	0.444	0.366
11. Pessim.	1.250	0.810	104	0.406	−0.153
12. Pleas.	1.150	0.734	104	0.200	−0.217

Note. EnjRel. = positivity relinquishment; EnjAvoid. = positivity avoidance; Worst = BAI5/fear of worst happening; Scared = BAI17/scared; Relax = BAI4/unable to relax; Sweats = BAI21/hot/cold sweats; Worth. = BDI14/worthlessness; Interest = BDI12/loss of interest; Energy = BDI15/loss of energy; Sad = BDI1/sadness; Pessim. = BDI2/pessimism; Pleas. = BDI4/loss of pleasure.

3.2. Resulting network and communities

3.2.1. Network 1: Positivity relinquishment

Fig. 1a represents the resulting network after redundant nodes were combined, displaying three emerging communities mirroring three measures included in the analysis. Significant differences were found between certain edges in the network, as indicated by bootstrapped difference tests (Fig. S2). *Worth/Inter* and *Pessi/Pleas* shared the strongest edge-weight (EW = 0.37), which was significantly different from 86 % of the other edges in the network. *Worst* and *Scared* shared the second strongest edge-weight (EW = 0.26) and was significantly different from 68 % of the other edges.

3.2.1.1. Centrality indices. The correlation stability coefficient (CS-coefficient) was calculated for the expected influence, revealing a value of 0.37, which is below the preferred cutoff of 0.5, but above the acceptable cutoff of 0.25 (Epskamp et al., 2018). Fig. 1b displays the one-step and two-step expected influence of each node. The nodes pessimism/pleasure ($EI_1 = 0.82$), worthless/interest ($EI_1 = 0.76$), and worst ($EI_1 = 0.59$) emerged as having the highest one-step expected influence. The nodes pessimism/pleasure ($EI_2 = 1.30$), worthlessness/interest ($EI_2 = 1.24$), and energy ($EI_2 = 0.92$) emerged as having the highest two-step expected influence. Bootstrapped difference tests revealed that these EIs were not significantly different from one another, however pessimism/pleasure and worthless/interest were significantly stronger than Enj_Relinq, Relax, and Sweats (Fig. S3), indicating that the former two nodes are the strongest in the network.

The correlation stability coefficient (CS-coefficient) was calculated for the bridge expected influence, revealing a value of 0.05, which is below the acceptable cutoff of 0.25 (Epskamp et al., 2018), and should be interpreted with caution. One and two-step bridge expected influence

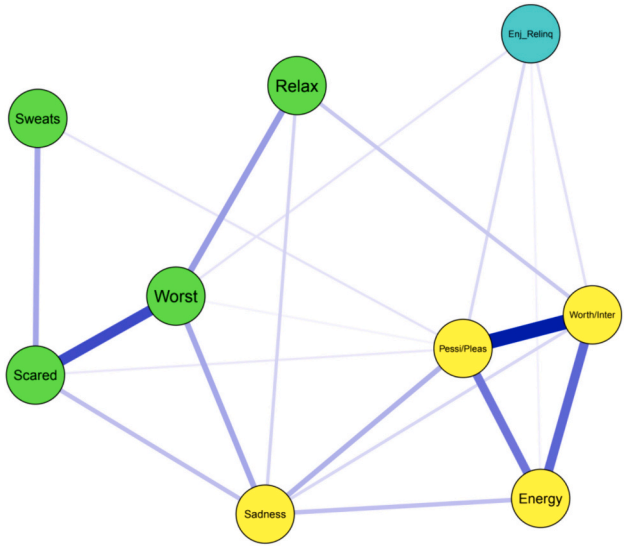

Fig. 1a. Positivity relinquishment network.
Note. Network of BDI, BAI, and Positivity Relinquishment after combining for redundancy. Communities are color-coded. Yellow = BDI; Green = BAI; Turquoise = Positivity Relinquishment. Blue lines, or edges, between nodes represent positive associations. Enj_Relinq = positivity relinquishment; Worst = fear of worst happening; Scared = scared; Relax = unable to relax; Sweats = hot/cold sweats; Worth/Inter = combined node of worthlessness and loss of interest; Energy = loss of energy; Sadness = sadness; Pessi/Pleas = combined node of pessimism and loss of pleasure.

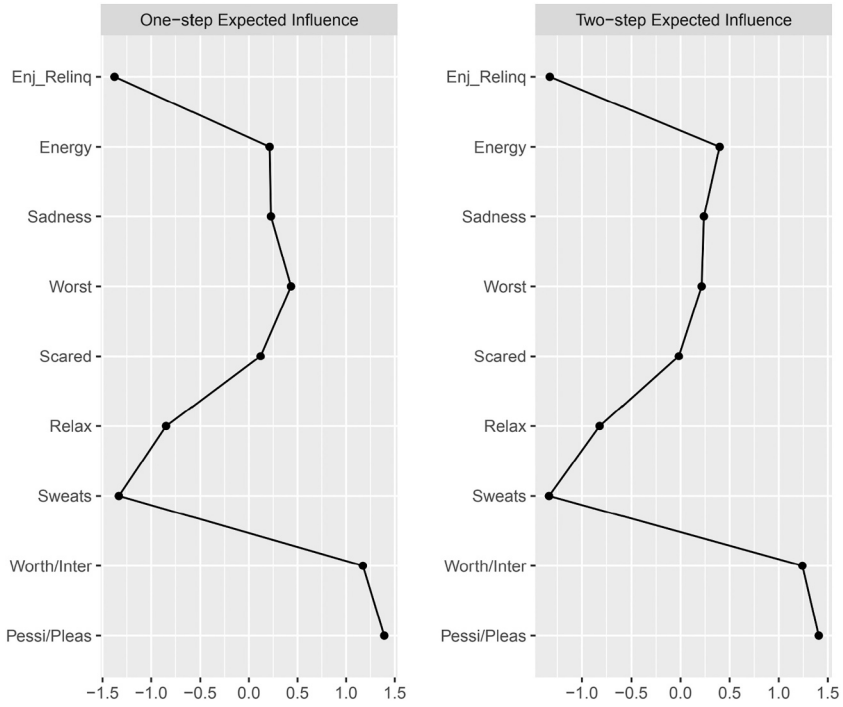

Fig. 1b. Positivity relinquishment network expected influence
Note. One and two-step expected influence of each node.

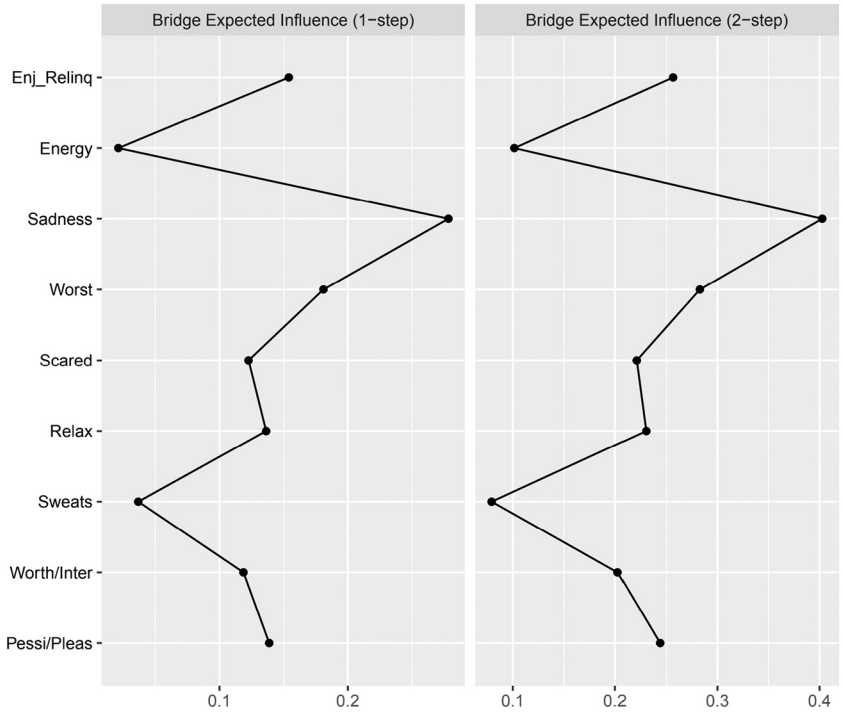

Fig. 1c. Positivity relinquishment network bridge expected influence
Note. One and two-step bridge expected influence of each node.

is depicted in Fig. 1c. *Sadness* ($EI_1 = 0.28$; $EI_2 = 0.40$), *worst* ($EI_1 = 0.18$; $EI_2 = 0.28$), and *enj_relinq* ($EI_1 = 0.15$; $EI_2 = 0.26$) emerged as having the highest one and two-step bridge expected influence; however, bootstrapped difference tests revealed that these bridge EIs were not significantly different from one another or any of the other bridge EIs (Fig. S4).

3.2.2. Network 2: Positivity avoidance

Fig. 2a represents the resulting network after redundant nodes were combined, displaying three emerging communities mirroring three measures included in the analysis. Significant differences were found between certain edges in the network, as indicated by bootstrapped difference tests (Fig. S5). As found in the first network, *Worth/Inter* and *Pessi/Pleas* shared the strongest edge-weight (EW = 0.36), which was

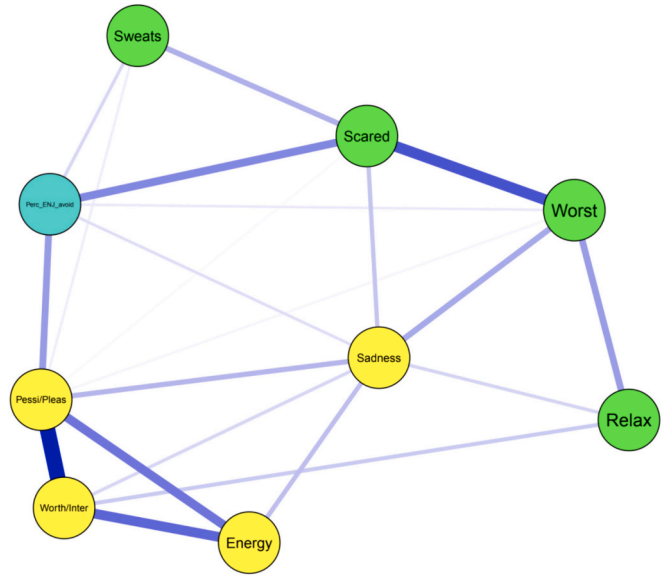

Fig. 2a. Positivity avoidance network
Note. Network of BDI, BAI, and Positivity Avoidance after combining for redundancy. Communities are color-coded. Yellow = BDI; Green = BAI; Turquoise = Positivity Avoidance. Blue lines, or edges, between nodes represent positive associations. Perc_Enj_Avoid = positivity avoidance; Worst = fear of worst happening; Scared = scared; Relax = unable to relax; Sweats = hot/cold sweats; Worth/Inter = combined node of worthlessness and loss of interest; Energy = loss of energy; Sadness = sadness; Pessi/Pleas = combined node of pessimism and loss of pleasure. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

significantly different from 77 % of the other edges. Albeit not among the strongest edges in the network, a few key edges emerged between nodes of *different communities*, which were otherwise weakly connected in the first network. Specifically, *Perc_Enj_Avoid* formed the strongest edges with the BAI node *Scared* (EW = 0.17) and the BDI node *Pessi/Pleas* (EW = 0.14), whereas the next strongest edge-weight that *Perc_Enj_Avoid* shared was relatively week and with *Sweats* (EW = 0.07).

3.2.2.1. Centrality indices. The correlation stability coefficient (CS-coefficient) was calculated for the expected influence, revealing a value of 0.28, which is below the preferred cutoff of 0.5, but above the acceptable cutoff of 0.25 (Epskamp et al., 2018). Fig. 2b displays the one-step and two-step expected influence of each node. The nodes pessimism/pleasure ($EI_1 = 0.85$; $EI_2 = 1.34$), worthless/interest ($EI_1 = 0.71$; $EI_2 = 1.18$), and scared ($EI_1 = 0.62$; $EI_2 = 0.90$) emerged as having the highest one-step expected influence. Bootstrapped difference tests revealed that these EIs were not significantly different from one another, however pessimism/pleasure was significantly stronger than Perc_Enj_Avoid, Relax, and Sweats; worthless/interest was significantly stronger than Relax and Sweats; and Scared was significantly stronger than Sweats (Fig. S6).

The correlation stability coefficient (CS-coefficient) was calculated for the bridge expected influence, revealing a value of 0.125, which is below the acceptable cutoff of 0.25 (Epskamp et al., 2018), and should be interpreted with caution. One and two-step bridge expected influence is depicted in Fig. 2c. *Perc_Enj_Avoid* ($EI_1 = 0.45$; $EI_2 = 0.67$), *sadness* ($EI_1 = 0.30$; $EI_2 = 0.44$), and *scared* ($EI_1 = 0.26$; $EI_2 = 0.37$) emerged as having the highest one and two-step bridge expected influence. Bootstrapped difference tests revealed that these bridge EIs were not significantly different from one another; however, *Perc_Enj_Avoid* was significantly stronger than some of the nodes, including *Energy* and *Sweats* (Fig. S7).

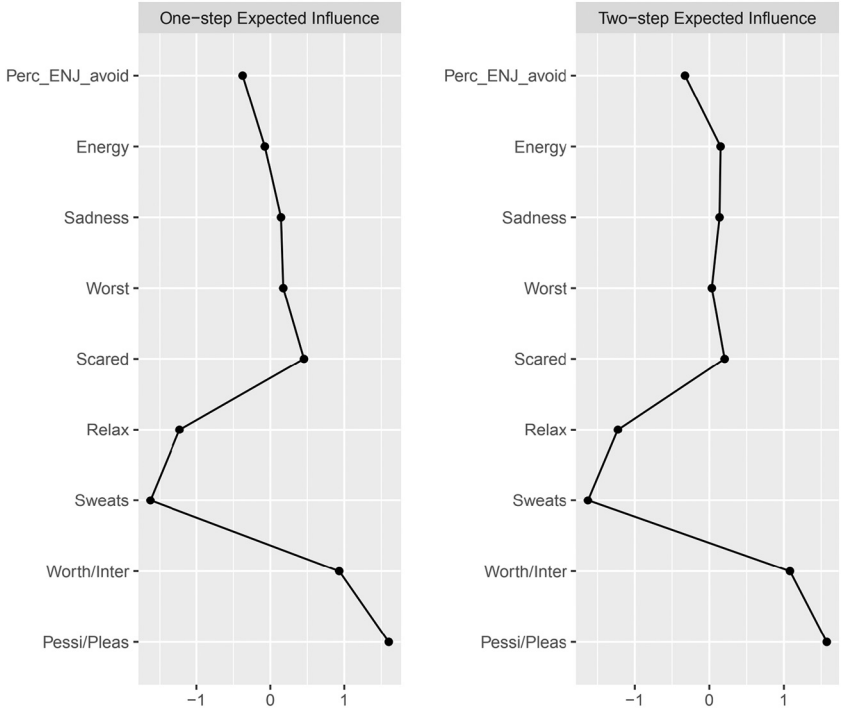

Fig. 2b. Positivity avoidance network expected influence
Note. One and two-step expected influence of each node.

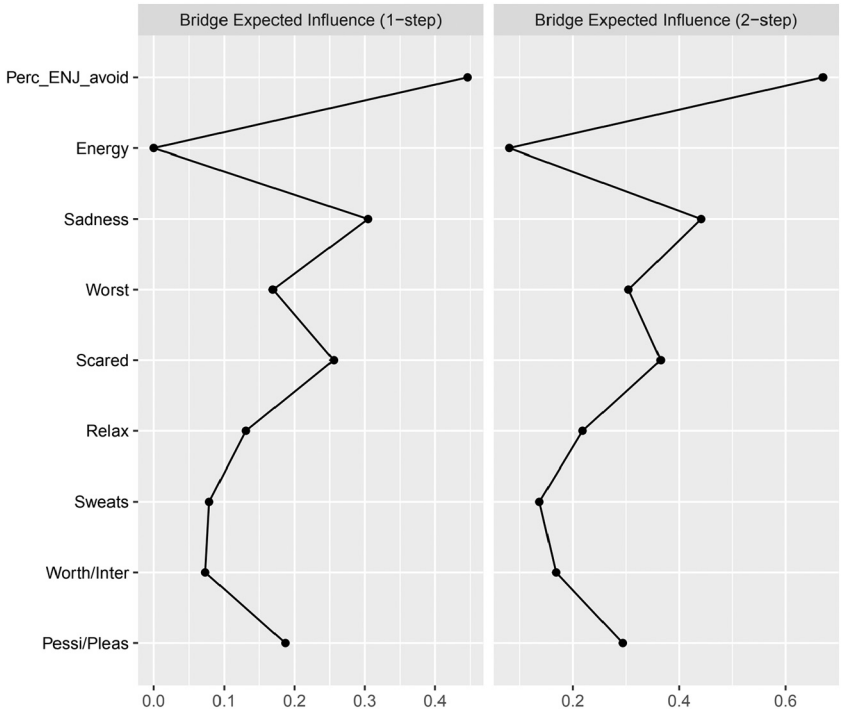

Fig. 2c. Positivity avoidance network bridge expected influence
Note. One and two-step bridge expected influence of each node.

3.2.3. *Network 3: Combined positivity relinquishment and avoidance network*

At the request of a reviewer, and as a deviation from our pre-registered analytic plan, we conducted an additional network with *Enj_Relinq* and *Perc_ENJ_Avoid* included in the same network, along with all other BAI and BDI items. As with the first two networks, *Worth/Inter* and *Pessi/Pleas* were the two resulting nodes after redundancy analyses. Fig. 3a represents the resulting network. Interestingly, and differing from the first network, *Enj_Relinq* only formed edges with Perc*_Enj_Avoid* and the anhedonia items, *Worth/Inter* and *Pessi/Pleas.* Significant differences were again found between certain edges in the network, as indicated by bootstrapped difference tests (Fig. S8).

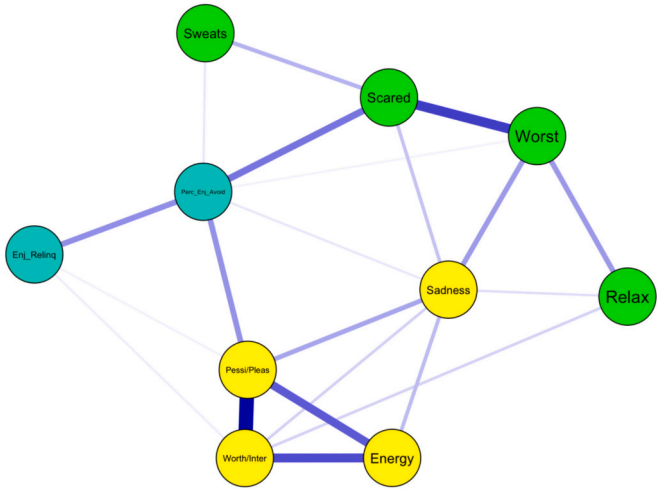

Fig. 3a. Positivity relinquishment and avoidance network
Note. Network of BDI, BAI, and Positivity Avoidance after combining for redundancy. Communities are color-coded. Yellow = BDI; Green = BAI; Turquoise = Positivity Relinquishment and Avoidance. Blue lines, or edges, between nodes represent positive associations. Perc_Enj_Avoid = positivity avoidance; Enj_Relinq = positivity relinquishment, Worst = fear of worst happening; Scared = scared; Relax = unable to relax; Sweats = hot/cold sweats; Worth/Inter = combined node of worthlessness and loss of interest; Energy = loss of energy; Sadness = sadness; Pessi/Pleas = combined node of pessimism and loss of pleasure. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

3.2.3.1. Centrality indices. The correlation stability coefficient (CS-coefficient) was calculated for the expected influence and edge, both revealing a value of 0.28, which is below the preferred cutoff of 0.5, but above the acceptable cutoff of 0.25 (Epskamp et al., 2018). Fig. 3b displays the one-step and two-step expected influence of each node. The nodes pessimism/pleasure (EI1 = 0.74; EI2 = 1.15), worthless/interest (EI1 = 0.65; EI2 = 1.03), and energy (EI1 = 0.45; EI2 = 0.75) emerged as having the highest one-step expected influence and were all within the same community. Bootstrapped difference tests revealed that these EIs were not significantly different from one another, however pessimism/pleasure was significantly stronger than Perc_Enj_Avoid, Relax, and Sweats, and worthless/interest was significantly stronger than Perc_Enj_Avoid, Relax, and Sweats (Fig. S9).

The correlation stability coefficient (CS-coefficient) was calculated for the bridge expected influence, revealing a value of 0.05, which is below the acceptable cutoff of 0.25 (Epskamp et al., 2018), and should be interpreted with caution. One and two-step bridge expected influence is depicted in Fig. 3c. As found in the second network, Perc_Enj_Avoid (*EI1* = 0.33; *EI2* = 0.48), sadness (*EI1* = 0.23; *EI2* = 0.32), and scared (*EI1* = 0.21; *EI2* = 0.29) emerged as having the highest one and two-step bridge expected influence. Bootstrapped difference tests revealed that these bridge EIs were not significantly different from one another; however, Perc_Enj_Avoid was significantly stronger than Energy (Fig. S10).

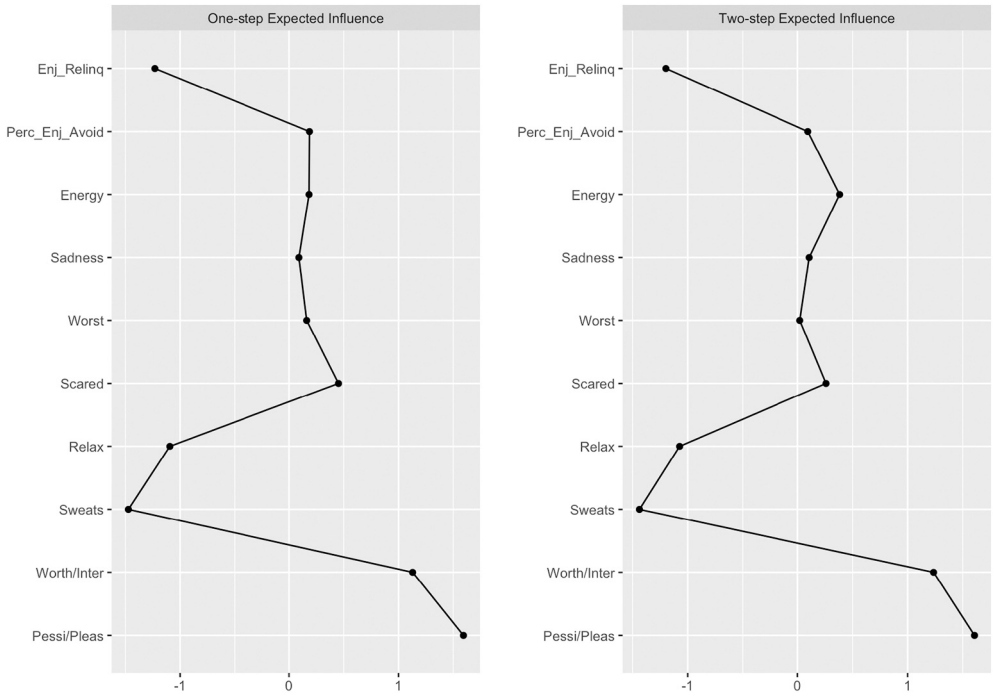

Fig. 3b. Positivity relinquishment and avoidance network expected influence
Note. One and two-step expected influence of each node.

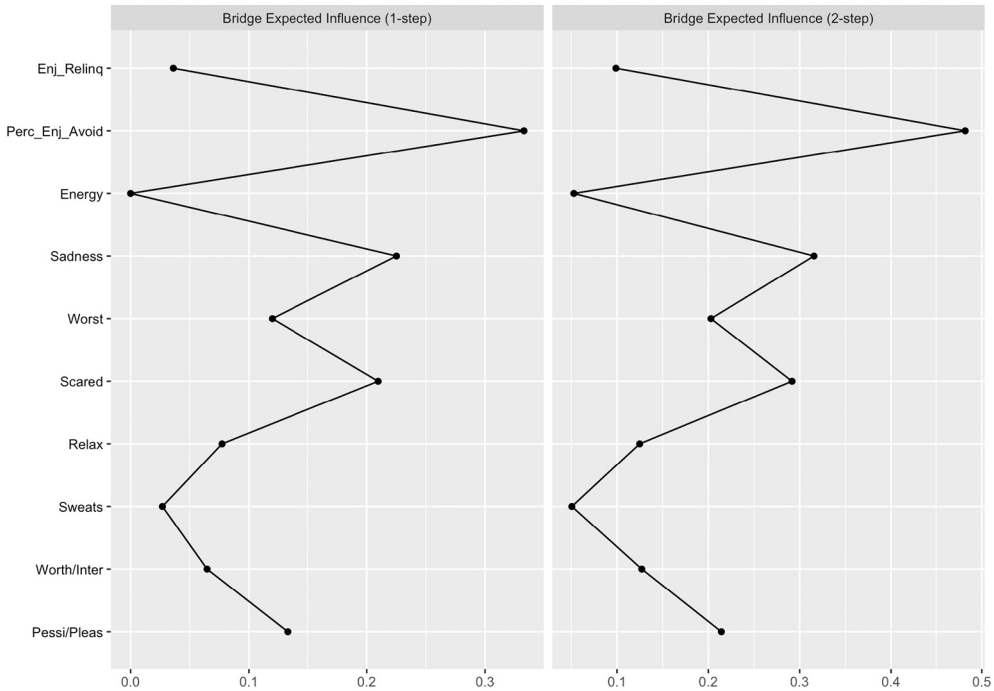

Fig. 3c. Positivity avoidance network bridge expected influence
Note. One and two-step bridge expected influence of each node.

4. Discussion

In network one, positivity relinquishment, and in networks two and three, positivity avoidance, were found to be central symptoms bridging anxiety and depression. The striking similarities and intriguing differences between the three networks speak to the nuances serving as a foundation to a comorbid expression. Moreover, even with both positivity items included, the network largely mirrors the second network with positivity avoidance, suggesting that this construct may be more important in the comorbidity of anxiety and depression in the current study. The bridging capacity of positivity relinquishment and avoidance demonstrates how conceptualization of comorbid anxiety and depression is informed by reward devaluation theory.

4.1. Community emergence

Results of the community analysis indicated three clear emerging communities: symptoms of anxiety, symptoms of depression, and positivity relinquishment/avoidance, respectively, replicating the measures that they were taken from. This did not differ across the three networks.

4.2. Influential nodes

In all three networks, anhedonia adjacent nodes, namely pessimism/loss of pleasure and worthlessness/loss of interest had the greatest expected influence. This provides further evidence for the transdiagnostic importance of anhedonia beyond depressive diagnoses (Cramer et al., 2010; Winer et al., 2017, studies 2 and 3).

Interestingly, positivity avoidance, in the Positivity Avoidance Network, had a greater expected influence than positivity relinquishment in the Positivity Relinquishment Network (though see bridge symptoms below). Including both nodes in the Combined Network revealed further insight into how these two constructs differ: positivity avoidance again had a greater expected influence, albeit they did not differ significantly.

4.3. Bridge symptoms

4.3.1. Replicated findings of avoidance of positivity

As hypothesized, positivity relinquishment and positivity avoidance served as robust network bridges for symptoms of anxiety and depression in each network. Despite including two different items from the positivity assessment measure, all three networks displayed similar findings, providing convergent evidence that devaluing reward can connect symptoms of depression and anxiety together. However, diverging from the findings of Winer et al. (2017), positivity avoidance was found to be slightly more influential in the bridge analysis than was positivity relinquishment. When both nodes were included in the same network, positivity avoidance remained more influential as a bridge symptom than positivity relinquishment.

Winer et al. (2017) proposed that positivity avoidance was not enough to explain the relationship between anxiety and depression based on their moderation findings; rather it was positivity *given up* due to the act of avoidance. Our findings suggest a more complex pattern, with both items exhibiting strong central tendencies in the network. We believe that the added specificity provided by network analysis is what revealed this more complex pattern and that it was bolstered by sadness serving as another potent bridge symptom between anxiety and depression. In other words, there seem to be multiple prospective routes toward comorbidity outlined within these networks.

4.3.2. Further implicating sadness as a bridge symptom

The current investigation examined individual symptoms as part of an overarching complex structure to gauge which symptoms were more likely to act as hubs or bridges, whereas anxiety and depression were examined as sum scores in Winer et al. (2017). Investigation of depression and anxiety as heterogeneous constructs in the current study, rather than as single syndromes, revealed that our novel questions about avoidance of positivity continued to act as bridges between anxiety and depression as they had in the moderation analysis in Winer et al. (2017). However, in the current study, sadness emerged as a separate, but important bridge symptom between other symptoms of anxiety and depression. This was evident in all three networks, however was particularly the case in the Positivity Relinquishment Network, having the greatest bridge influence in the network, although it was not significantly different than the other bridge nodes of high expected influence (i.e., the anxiety symptom "worst"). This provides surprising supporting evidence for the DSM-5 practice of having anhedonia and sadness as core symptoms of depression (see Fried and Nesse, 2015 for critique), but also has novel implications regarding sadness connecting other symptoms of depression and anxiety.

Interestingly, in all three networks the three nodes with the highest bridge influence came from three different communities. In the Positivity Relinquishment Network, sadness, fear of worst happening, and positivity relinquishment had the greatest bridge impact. In the Positivity Avoidance Network and Combined Network, positivity avoidance, sadness, and scared had the greatest bridge impact. This is quite interesting in that the symptoms that emerged from the anxiety self-report as most connected to this narrative both involved fear.

Moreover, all three networks uncovered an anhedonia circuit, which connected to sadness and connected to the anxiety cluster via the positivity avoidance/relinquishment item. These networks support prior research that anhedonia is central to a more global reward devaluation presentation (Calafiore et al., 2024; Collins et al., 2021; Eysenck and Fajkowska, 2018; Jordan et al., 2021), which is associated with the development of anxiety symptoms from depressed symptoms or vice versa. Winer et al. (2017) found in their third study that anxiety measured at time 1 predicted anhedonia at time 2, which predicted depression at a more distant time point. This temporal model would be in support of our findings implicating a pathway in which anxiety and depression are connected via mechanisms of reward devaluation. The cross-sectional nature of the current study limits our ability to establish a temporal precedence using network analysis; however, future work can aim to investigate the relationship between depression, anxiety, and reward devaluation over time in a network.

As hypothesized, a node evaluating reward devaluation bridged the two groups of symptoms in the second and third networks. Positivity avoidance had the highest bridge expected influence; however, it also had low overall expected influence. This makes reward devaluation a uniquely precise bridge symptom: it was not directly related to other symptoms but was highly influential on comorbidity between symptom clusters.

4.4. Clinical implications

Discerning how an individual's relationship with prospective positivity impacts the development and maintenance of anxious, depressed, and comorbid presentations could be incredibly important to treatment. By understanding the pathways that symptoms take in the development of further symptoms within a comorbid presentation using network analysis allows treatment to target the bridge processes (Dobson et al., 2021).

While populations exhibiting high levels of anhedonia might very well require a Positive Affect Treatment (PAT), differing from typical depression treatments that solely seek to reduce negative affect (Craske et al., 2016), the findings presented here present a potential obstacle to treatment efficacy. Findings presented by Bryant et al. (2023) suggest that individuals who fear prospective reward perceived positive affect treatments as having a poor fit. We must first understand the nuance of the reward devaluation process to adequately apply them to treatment.

The two reward devaluation items included in this study are seemingly very similar, however produce different outcomes in their respective networks. Positivity avoidance is assessing how much an individual is avoiding potentially enjoyable activities due to their anxiety. Positivity relinquishment takes it a step further by assessing the extent to which the individual is aware of the enjoyment that they would get out of the avoided activities if they were able to engage in them without the presence of anxiety. What these items have in common and what the positivity relinquishment item specifically harps on, is that this is not depicting anhedonia, in the sense that an individual is unable to experience pleasure. This is not a biological deficit. Rather it is an active and effortful inhibition of positive experiences driven by an anxious fear that is working to produce depressive symptoms.

Definitions of anhedonia range, inhibiting a cohesive attempt to understand its role in the development and maintenance of psychopathology. Here we focused on how relinquishment related to lack of

pleasure represented a change from usual functioning. Underlying this cognitive/affective decision are the motivational and anticipatory processes in relation to expectations of positivity and effort to experience positivity outlined by RDT that contribute to the experience of anhedonia (Winer and Salem, 2016). While the items that highly anxious individuals were asked cannot fully encompass these multifaceted aspects of anhedonia (see Winer et al., 2019, for a review that concludes that it may be better to theoretically parse anhedonias instead of a single-construct anhedonia), asking about relinquishment and avoidance get at the primary cognitive/affective elements most related to RDT. These findings provide supporting evidence for Calafiore et al. (2024) in which they found that both anhedonia and fear of happiness uniquely predicted depressive symptoms when accounting for the other. These constructs are related in this diagnostic picture; however they are not one in the same and should both be adequately assessed and targeted in research and in practice.

4.5. Limitations

The networks presented in this paper are not directional due to the cross-sectional data analyzed. We are unable to draw conclusions regarding directionality, such as depression leading to reward devaluation leading to anxiety or vice versa.

Furthermore, as with all network analyses, node selection is highly indicative of the strength of the results and implications of the findings. To ensure we were adequately powered, we were unable to include all BDI, BAI, and positivity assessment items in our networks. We instead were guided by recent relevant studies during the node selection process (Park and Kim, 2020; Jacobson and Newman, 2014; Winer et al., 2017). We believe this added layer of a priori theorization strengthened the overall study; however, there could have been other nodes that potentially would have functioned as more predictive bridges between anxiety and depression via reward devaluative pathways.

As stated, the bridge EIs in the networks were found to be unstable and findings related to these should be interpreted with caution. This could suggest that the bridge nodes were not consistent across samples of data, indicating greater variability than discussed. This finding highlights the need for further investigation of the nodes implicated in this study for their bridging role in this system of symptoms.

Additionally, although the data used in this study were in many ways ideal for answering our research question, they were archival and therefore we were unable to alter the data collection process in any way. Notably, the current sample size only included 104 participants, which can be considered small for a network analysis. However, the number of observations in the networks did exceed the maximum number of edges that could be estimated, and our CS-coefficients were above the acceptable thresholds for expected influence and edge-weights, despite the smaller sample size. Only those who scored highly on the BAI were included in the original study; therefore, for the purposes of our present study, a potential confound of high BAI scores associated with a range of BDI scores is present.

Furthermore, other scales measuring depression and anxiety that more closely reflect the criteria outlined in the DSM-5, such as the Patient Health Questionnaire (PHQ-9) and Generalized Anxiety Disorder-7 (GAD-7) might have better suited the research question. In addition, our items representing positivity avoidance and relinquishment were created for the original study and thus have not been thoroughly assessed for psychometric reliability or validity. Future work can investigate the psychometric properties of this scale in nonclinical and clinical populations to better understand its utility.

Finally, the data included in this study was obtained from individuals via MTurk. While there are many advantages to using such a software, such as reaching participants outside of undergraduate psychology samples, MTurk is not necessarily representative of the generalized population and is likely underrepresenting certain groups of people, such as Black and Hispanic individuals (Follmer et al., 2017). MTurk has also been associated with sampling bias (Webb and Tangney, 2022).

4.6. Future directions

Future research should use temporal data to examine potential causal relationships between these variables (Jordan et al., 2018). Although prior work has linked depression and anxiety via avoidance (Jacobson and Newman, 2014), it is important to investigate how these dynamics unfold over time and which comes first (i.e., depression/anxiety or avoidance). Indeed, a temporal relationship between these constructs could provide crucial insight into the development, maintenance, and treatment of depression and anxiety. In addition, researchers could aim to investigate whether these findings replicate in a larger sample size to enable researchers to examine all DSM-5 symptoms of anxiety and depression within their networks. However, it is important to note that, in the current study, these nodes were theoretically derived and that other heterogeneous nodes (e.g., loss of appetite and increased appetite) could limit the networks' ability to home in on bridge symptoms. The collection of findings from the current study utilizing network modeling and the original Winer et al. (2017) study 1, provide compelling empirical evidence of discerning what leads to comorbidity has been validated, translating the idea into the clinical realm is essential for future research. Using a group of individuals with elevated anxiety, the current study provides findings suggesting who will – and who will not – have elevated symptoms of depression. However, including a clinical sample in future research can more adequately inform this conceptualization.

Whereas anhedonia is largely studied and recognized for its transdiagnostic impact (Barkus, 2021), our findings suggest that positivity relinquishment and avoidance are central symptoms bridging depression and anxiety networks. As it stands now, these are not aspects of the depressed, anxious, or comorbid presentations that are assessed when guided by the categorical DSM-5 (APA, 2013). This is potentially inhibiting the field's ability to distinguish key aspects that bridge depression and anxiety and thus our understanding of their intricate development and prognosis.

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CRediT authorship contribution statement

Camryn Calafiore: Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Amanda C. Collins:** Writing – review & editing, Supervision, Formal analysis. **Gregory Bartoszek:** Writing – review & editing, Investigation, Data curation. **E. Samuel Winer:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

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

Data availability

The materials related to the current study, including data and analytic code, are publicly available at https://osf.io/yh4g6/?view_only=7d508b906eb4494b89a6763bfa971610.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jad.2024.08.031.

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