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RESEARCH ARTICLE

A replication and extension of bifactor modelling of perseverative thought in an at-risk community sample: Exploring sex differences in the structure of PT

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Abstract

Background: Perseverative thought (PT) is a transdiagnostic construct associated with internalizing disorders. Bifactor models have shown that PT can be split into a general PT factor and lower-order factors for specific forms of PT, such as rumination and worry. No bifactor study to date has investigated if the structure of PT differs across sexes.

Methods: The study consisted of 280 individuals recruited for a larger study targeting risk factors for suicidal ideation and behaviours. Participants completed a diagnostic interview and self-report questionnaires.

Results: A two-factor model of PT fit best in males, whereas a bifactor model fit best in females. In a structural equation model, worry was associated with generalized anxiety disorder diagnoses in females, but not males. Rumination was associated with depressive disorder diagnoses in females, but not males.

Conclusions: The present study contributes to a growing literature on PT; we found that dimensionality of PT varied by sex. We also found that relations between PT factors and generalized anxiety disorder differed by sex. Sex differences in the internalizing spectrum and related risk factors need to be considered when examining the structure and function of risk factors.

KEYWORDS

event-related potentials, perseverative thought, rumination, structural equation modelling, worry

Practitioner points

- This study focuses on the overarching construct of perseverative thought (PT). These findings may be helpful for clinicians in understanding the ways in which rumination and worry may be related to anxiety and depression.
- This study also focuses on sex differences in rumination, worry and PT. These findings may be helpful to clinicians in that it provides a nuanced view on previous literature that has shown that rumination is more prevalent in women.
- These findings provide additional evidence of the relationship of rumination with depression. This may be helpful to clinicians as a means of designing treatments that may reduce depression.
- These findings provide additional evidence of the relationship of PT with anxiety and depression. This may be helpful to clinicians as a means of designing transdiagnostic treatments that can be used to reduce anxiety and depression.

INTRODUCTION

Perseverative thought (PT) reflects the tendency to engage in repetitive and often negative thoughts (Ehring & Watkins, 2008). There is emerging evidence that PT is a higher-order factor underlying worry and rumination (Ehring & Watkins, 2008). Rumination refers to a past-focused, emotion-driven form of PT. Worry is an "uncontrollable chain of thoughts." (Borkovec et al., 1982) In contrast to rumination, worry tends to be future-oriented and tends to focus on problem-solving rather than on emotions (Borkovec et al., 1982). Despite proposed differences, rumination and worry are both abstract, primarily verbal, with a repetitive focus on negative cognitions (Ruscio et al., 2011). Despite their similarities, there is mixed evidence as to which level of the hierarchical structure representing PT most contributes to the aetiology of GAD and MDD.

There is evidence that rumination may be a specific lower-order risk factor for depression. Rumination was initially considered a specific risk factor for MDD (e.g., Nolen-Hoeksema, 2004) and has since been argued to be a risk factor (e.g., Harding & Mezulis, 2017), a cognitive symptom of depression (Bartoskova et al., 2018) and an associated feature of major depressive disorder (American Psychiatric Association, 2013). For example, Nolen-Hoeksema (1991) found that ruminating was associated with a greater likelihood of depression and longer duration depressive episodes. Olatunji et al. (2013) conducted a meta-analysis and found that rumination was broadly associated with internalizing disorders, although the association was strongest for MDD than for anxiety disorders ($d = .53$, $p < .001$). Importantly, the meta-analysis did not control for the impact of worry (or other forms of PT) on the association between rumination and disorders. In sum, rumination is elevated in individuals with internalizing disorders relative to individuals without internalizing disorders but is most elevated in individuals with MDD diagnoses.

There is also evidence that worry is a specific lower-order risk factor. The link between worry and anxiety disorders is well established (Olatunji et al., 2010). Worry has also been shown to be associated with other internalizing disorders, such as MDD. For example, Olatunji et al. (2010) found that those with MDD have elevated worry, but those with anxiety disorders have significantly higher worry than individuals with MDD. Moreover, the previous review did not account for levels of rumination or PT in general when investigating the association between worry and psychopathology. As with rumination, there is a dearth of literature examining the influence of worry when controlling for rumination, with most studies using correlational approaches or investigating either rumination or worry in separate models. In sum, worry is elevated in individuals with internalizing disorders compared to those without internalizing disorders, but worry is most elevated in individuals with a GAD diagnosis.

Although worry and rumination are most strongly related to MDD and GAD, respectively, it is possible that the variance attributable to these two risk factors is more parsimoniously captured by PT. This might suggest that these disorders could be most effectively targeted at the higher-order level reflecting comorbid features between these disorders. Harvey et al. (2004) proposed that although different disorders may have unique ways in which PT is displayed (e.g., worry in anxiety and rumination in depression), all of these unique manifestations reflect a core underlying PT component that cuts across diagnostic categories. Indeed, Ehring et al. (2011) found that a disorder independent measure of PT was highly correlated with both rumination (*r*'s ranging from .56 to .67) and worry (*r*'s ranging from .46 to .68), although these correlations were weaker in clinical samples versus non-clinical samples. In sum, the evidence suggests that PT, rumination and worry are moderately correlated. However, these studies do not explain what accounts for this comorbidity.

Factor analysis, a data-driven approach that can model common and unique variance for indicators representing one or more constructs, has been applied to explore the hierarchical structure of PT. Exploratory factor analyses and correlated factors confirmatory factor analyses have supported distinct worry and rumination factors (Fresco et al., 2002; McEvoy & Brans, 2012); however, these studies do not clarify whether the lower-order factors capture meaningfully different variance or whether a more parsimonious general factor is supported (Bornovalova et al., 2020).

Bifactor modelling is a form of factor analysis that allows researchers to partition and assess shared and unique variance of constructs like PT that have higher- and lower-order dimensions (Reise, 2012). There is much recent support for bifactor models of PT (e.g., Hur et al., 2017; Samtani et al., 2021; Spinhoven et al., 2018). Spinhoven et al. (2018) used bifactor CFA to analyse the structure of a general measure of PT (the Perseverative Thought Questionnaire), a measure of rumination (the Leiden Index of Depression Sensitivity) and a measure of worry [the Penn State Worry Questionnaire (PSWQ)]. The bifactor solution with a general PT factor and three different specific factors for each measure fit the data best, compared to a single-factor model, a three-factor model and a hierarchical model. The lower-order factors of PT (3.3% of variance explained), rumination (6.3%) and worry (10.6%) contributed minimal unique variance, beyond that explained by the general factor (79.7%). Omega hierarchical (ω_h) and omega-specific (ω_s) values revealed that each of the lower-order factors did not reliably measure variance above and beyond the general factor's reliability. In a sample of undergraduates, Hur et al. (2017) found that a bifactor model of rumination and worry fit significantly better than two-factor and single-factor models. The worry-specific factor predicted outcomes above and beyond the general PT factor, with the worry factor predicting avoidance temperament, anxious arousal and approach temperament. Topper et al. (2014) found that a bifactor model of rumination and worry, and a general factor fit significantly better than a two-factor model of rumination. The authors also found that the general PT factor was associated with symptoms of depression and anxiety in undergraduate students, though they did not provide estimates of the variance that this factor accounted for in both. In support of PT as a general unifying factor, a study by Castro et al. (2022) using 14 independent data sets found that a general factor negative repetitive thinking fit the data best for worry and rumination. Thus, there is evidence that the general factor captures the most meaningful variance in PT.

Although bifactor models have fit appropriately for the structure of PT, it remains unclear if the specific factors in these models are meaningful and reliable in their relations with internalizing symptoms. Both Spinhoven et al. (2018) and Samtani et al. (2021) found that lower-order factors of rumination were associated with symptoms of depression, above and beyond that of a general PT factor. In contrast, worry was associated with anxiety symptoms in the Spinhoven et al. (2018) paper, but not the Samtani et al. (2021) paper. However, there were differences in how PT was measured in these studies. Although Spinhoven and colleagues examined PT, rumination and worry only, Samtani and colleagues examined a broader PT construct, including repetitive thinking questionnaire (McEvoy et al., 2010), response to positive affect-dampening (Feldman et al., 2008), perseverative thinking questionnaire (Ehring et al., 2011), ruminative response styles-brooding, ruminative response styles reflection (Nolen-Hoeksema & Morrow, 1991) and PSWQ (Meyer et al., 1990). In sum, the extant literature

shows that when modelled as a bifactor solution, rumination appears to show distinct associations with internalizing symptoms, above and beyond the association that the general factor has with these symptoms, whereas the findings regarding worry are equivocal. Thus, more work is needed to clarify how PT is related to generalized anxiety and depression.

Sex differences in PT

One possible explanation for the inconsistent findings in prior studies is that sex differences in the underlying structure of PT and in its relations with generalized anxiety and depression have not been considered. A substantial body of research has demonstrated sex differences in anxiety disorders (e.g., McLean & Anderson, 2009) and depressive disorders (e.g., Nolen-Hoeksema, 1987). These differences have been posited to be due to a variety of factors, including differences in responses to anxiety and/or depression. For example, response styles theory posits that gender differences in depression are due to differences in responses to sad mood, with women being more likely to ruminate in response to negative emotions, whereas men are more likely to distract (Nolen-Hoeksema, 1987). Indeed, these differences in rumination are proposed to explain sex differences in the development of depressive disorders in women relative to men (Kessler et al., 2005). Further, meta-analytic evidence supports women have higher levels of general rumination, brooding rumination and reflection compared to men (Johnson & Whisman, 2013). Likewise, previous research has also demonstrated that women tend to have higher levels of worries compared to men (Robichaud et al., 2003). It has been argued that difference in worries may reflect a tendency for women to internalize their distress, whereas men are more likely to externalize their distress (Robichaud et al., 2003). When examining the higher-order construct of PT, the evidence for sex differences is more mixed. For example, although McEvoy et al. (2019) found that adolescent girls had higher levels of PT compared to boys, research in clinical samples of adults have found no such sex differences (Mahoney et al., 2012). In sum, although sex differences have been noted for rumination and worry, the evidence for sex differences in PT is mixed. Further, research is needed to examine whether sex differences extend to the relations these risk factors share with generalized anxiety and depression.

The present study

The purpose of the present study was to examine the underlying structure of PT. In the present study, we examine sex differences in contemporary CFA models, including bifactor models, of PT and extend this to structural equation model (SEM) of these factors in relation to generalized anxiety disorder (GAD) and depression. Moreover, although past research has included a direct measure of PT (e.g., Samtani et al., 2021; Spinhoven et al., 2018), the present study uses measures specific to the lower-order PT dimensions to determine if these constructs when measured independently continue to create a shared PT construct. First, CFA was used to compare models of PT. Given evidence that depression (Nolen-Hoeksema & Hilt, 2009), anxiety (McLean et al., 2011), rumination (Johnson & Whisman, 2013) and worry (Robichaud et al., 2003) differ in males and females, these models were first tested independently in each sex. After the best-fitting model of PT was determined across sex, relations between the risk factors and generalized anxiety disorder (GAD) and major depressive disorder (MDD) diagnoses were examined. Based on prior research (i.e., Castro et al., 2022; Hur et al., 2017; McEvoy & Brans, 2012; Spinhoven et al., 2018; Topper et al., 2014), we hypothesized that a bifactor model would fit best in males and females. Moreover, we hypothesized that the general PT factor would be associated with both MDD and GAD diagnoses, whereas the lower-order worry and rumination factors would be specifically associated with GAD and MDD diagnoses, respectively.

METHODS

Participants

The full sample consisted of 304 individuals who presented for a randomized clinical trial targeting risk factors for suicidal thoughts and behaviours (ClinicalTrials.gov Identifier CT01941862). Eligibility criteria included being at least 18 years old, current suicidal ideation, or clinically significant elevations on one or more risk factors for suicidality [anxiety sensitivity cognitive concerns (Capron et al., 2013; Stanley et al., 2018), thwarted belongingness (Van Orden et al., 2010) and/or perceived burdensomeness (Van Orden et al., 2010)]. Individuals with severe suicide risk requiring immediate hospitalization or unmedicated bipolar or psychotic spectrum disorders were excluded from the larger study. All data analysed for the present study were conducted prior to treatment targeting risk factors for suicidality. Sixteen participants were excluded from participation in the randomized clinical trial. This left a final sample of 288 (M_{age} = 36.24 years, SD = 16.03 years; range 18 years old – 79 years old). Participants were relatively evenly distributed on biological sex (n = 157 female, 54.50%). The sample identified as primarily White (56.9% White, 30.2% African American/Black, 2.1% Asian, 10.1% Other). Approximately one-third of the sample were veterans (n = 91, 31.6%).

Self-report and clinician-administered measures

Penn State Worry Questionnaire – brief (PSWQ-brief)

The PSWQ-brief (Topper et al., 2014) is a five-item version of the PSWQ designed to assess individual differences in worry. In past research, the PSWQ-brief has demonstrated high sensitivity and specificity for clinically significant worry and predicted future anxiety symptoms (Topper et al., 2014). PSWQ-brief scores in the present sample (M = 17.93, SD = 5.57) were above the recommended cut-off of 15, which is likely to correspond to those with elevated levels of worry on the full PSWQ (Topper et al., 2014). In the current study, the PSWQ-brief demonstrated excellent internal consistency (α = .91).

Ruminative Response Scale – brief (RRS-brief)

The Ruminative Response Scale (RRS)-brief (Topper et al., 2014) is a five-item measure designed to assess individual differences in rumination. Past research developing the RRS-brief has demonstrated high sensitivity and specificity for clinically significant depression symptoms (Topper et al., 2014) and prospectively predicted depressive symptoms. RRS-brief scores in the present sample (M = 13.08, SD = 3.27) were above the recommended clinical cut-off for clinically significant depression (RRS-brief >9; Topper et al., 2014). In the current study, the RRS-brief demonstrated adequate internal consistency (α = .78).

Structured clinical interview for DSM-5, research version (SCID-5-RV)

The structured clinical interview for DSM-5, research version (SCID-5-RV; First et al., 2015) was used to assess psychiatric diagnoses. The SCID-5-RV was administered by highly trained doctoral-level therapists and reviewed by a licensed clinical psychologist. In the current study, the SCID-5-RV demonstrated excellent reliability (κ = .86). In line with the aims of the parent project, nearly all participants in the current study met criteria for at least one psychiatric diagnosis (n = 253, 91.3%), with 187 individuals meeting criteria for two or more diagnoses (64.9%). Further, 72 participants met criteria for a primary

or comorbid GAD diagnosis (25.0%), including 31 individuals with primary GAD (10.8%). Nearly half of the sample was diagnosed with a depressive disorder (MDD, persistent depressive disorder (PDD), Other-specified depressive disorder; $n = 143$, 49.70%) including 68 individuals meeting criteria for a primary depressive disorder (23.6%).

Experimental procedures

The SCID-5-RV and self-report questionnaires were administered in the initial session, and additional self-report questionnaires and neurophysiological tasks were captured in a subsequent session. In the present study, the PSWQ and diagnostic interviewing information came from the initial session, whereas rumination was assessed at the neurophysiological sessions.

Data analytic plan

All analyses were run using Mplus version 8.3 (Muthén & Muthén, 1998–2017). First, model comparisons were done between one-factor, two-factor and bifactor models of PT, separately in males and females, using the Yuan–Bentler scale chi-square test of model fit (Y-B χ^2; Yuan & Bentler, 2000). A significant difference in the Y-B χ^2 between models indicates that the more complex model is a better fit to the data. Model fit was assessed using the χ^2 test of model fit, comparative fit index (CFI), root mean square error of approximation (RMSEA), and the 90% confidence interval for the RMSEA, RMSEA CI values above .08 indicate that poor fit cannot be ruled out, whereas values below .06 indicate that good fit cannot be ruled out (MacCallum et al., 1996). A non-significant χ^2 indicates that the model fit the data well, CFI values above .90 and .95 indicate adequate and good fit, respectively, and an RMSEA below .06 indicates good fit (Hu & Bentler, 1999). RMSEA CI values above .08 indicate that poor fit cannot be ruled out, whereas values below .06 indicate that good fit cannot be ruled out (MacCallum et al., 1996). In addition to standard fit indices, explained common variance (ECV), percent uncontaminated correlation (PUC), and omega hierarchical ($Omega_H$) and omega-specific ($Omega_{spec}$) were evaluated for bifactor solutions to provide additional information relating to the viability of the specific lower-order factors, as bifactor solutions have been shown to produce well-fitting solutions with non-viable lower-order factors (Reise, 2012). When ECV values are above .70 and PUC values are above .70, the common variance can be regarded as unidimensional (Rodriguez et al., 2016). When PUC values are lower than .80, and ECV values are greater than .60, $Omega_H$ values suggest that multidimensionality is not enough to disqualify interpretation of the measure as unidimensional (Reise, 2012). Once the best-fitting model was determined for males and females separately, measurement invariance comparing PT in males and females was conducted in the model that was best-fitting across sexes (i.e., if a more complex model fit better in one sex but not the other, the less complex and therefore more parsimonious model was used to test measurement invariance). In a stepwise manner, configural invariance was tested across sexes (i.e., testing if the structure of the model differed between males and females), followed by metric invariance (i.e., testing if the loading of individual items differed between males and females), and scalar invariance (i.e., testing if the item intercepts differed between males and females). At each step, comparisons were made between the model with more restrictions versus the model at the previous step with less restrictions (e.g., configural vs. metric invariance, metric invariance vs. scalar invariance). In cases in which model fit was significantly different between the two models, modification indices were examined to assess empirically and theoretically defensible modifications to the model to improve fit (Brown, 2015). In cases where modifications were made to the model, partial invariance was said to be achieved for that step (i.e., partial metric invariance and partial scalar invariance). Following measurement invariance, a SEM was fit to examine the relations PT factors shared with diagnoses of depressive disorders and diagnoses of GAD. As

diagnostic categories are categorical in nature, the robust maximum likelihood (MLR) estimator was used for all analyses, as this estimator has been shown to be robust to missing data and categorical data (Ramoni & Sebastiani, 2001). Moreover, associations are presented as unstandardized for diagnostic categories as this allows calculation of odds ratios for each disorder. In addition, 95% confidence intervals of the odds ratios are provided for each association. Given the number of associations being tested in the present study, a Benjamini–Hochberg correction was used on the results, with all results being ranked based on significance level, and then having their rejection value adjusted based on the number of comparison ([rank/total tests] * .05; Benjamini, 2010). Only results that were significant after this correction are shown below. The RRS-brief was added to the study after all other variables and thus has a large proportion of missing data (~35% of responses missing); although MLR is robust to missing data (Ramoni & Sebastiani, 2001), we did examine how robust our findings were to exclude these participants and there were no substantive differences. Thus, results of the full sample are reported below.

RESULTS

Descriptive statistics

Means, SD and correlations for all study variables are provided in Table 1. All items fell well within acceptable skew (±2) and kurtosis (±7) for SEM with continuous variables (Curran et al., 1996).

CFA models of PT in males

CFA models were fit for the one-, two- and bifactor model of PT in males. The one-factor model provided poor fit to the data ($\chi^2 = 99.26$, $df = 35$, $p < .001$, CFI = .85, RMSEA = .12, 90% CI [.09 .15]). In contrast, the two-factor model provided good fit to the data ($\chi^2 = 27.08$, $df = 34$, $p < .001$, CFI = 1.00, RMSEA = .00, 90% CI [.00, .04]). Moreover, the two-factor model fit the data significantly better than the one-factor model ($\Delta\chi^2 = 214.95$, $\Delta\ df = 1$, $p < .001$). The bifactor model did not converge as is, and as such PSWQ-B item 3 ("When I am under pressure, I worry a lot") was set to load only on the general factor but not the specific worry factor. The bifactor model also provided excellent fit to the data ($\chi^2 = 15.21$, $df = 26$, $p < .001$, CFI = 1.00, RMSEA = .00, 90% CI [.00, .00]). There was a non-significant difference between the two-factor and bifactor model ($\Delta\chi^2 = 10.16$, $\Delta\ df = 8$, $p = .25$), suggesting that the two-factor model of PT was most appropriate (see Table 2, Panel 1). In addition, bifactor indices supported the unidimensionality of the PT construct (ECV = .65, PUC = .64, $Omega_H = .73$, $Omega_{Worry} = .15$, $Omega_{Rumination} = .51$).

TABLE 1 Pearson's correlations between rumination, worry, GAD diagnoses, MDD diagnoses and sex.

	1	2	3	4	5
Worry					
Rumination	.53***				
DEP	.05	.16***			
GAD	.17***	.08*	.01		
Sex	.17***	.07	.01	.06***	
Mean (% female/% diagnosed)	17.93	13.08	49.07%	25.00%	54.5%
SD	5.57	3.27			

Abbreviations: DEP = major depressive disorder diagnoses; GAD, generalized anxiety disorder diagnoses; SD, standard deviation.

***$p < .001$; *$p < .05$. Sex was coded as 1 for male and 2 for female.

TABLE 2 CFA results comparing one-, two- and bifactor models of PT.

	χ^2	df	$\Delta\chi^2$	CFI	RMSEA [90% CI]
Male					
One-factor	99.26	35		.85	.12 [.09, .15]
Two-factor	27.08	34	214.95***	1.00	.00 [.00, .04]
Bifactor	12.89	26	6.93	1.00	.000 [.00, .03]
Female					
One-factor	102.39	35		.87	.11 [.09, .14]
Two-factor	44.66	34	69.23***	.97	.05 [.00, .09]
Bifactor	26.28	26	16.74*	1.00	.01 [.00, .06]

Note: χ^2 = chi-square test of model fit; df = degrees of freedom; $\Delta\chi^2$ = Satorra–Bentler chi-square change; CFI = comparative fit index. RMSEA = root mean square error of approximation with 90% confidence interval.

***$p < .001$; *$p < .05$.

CFA models of PT in females

CFA models were fit for the one-, two- and bifactor model of PT in females. The one-factor model provided poor fit to the data ($\chi^2 = 102.39$, $df = 35$, $p < .001$, CFI = .87, RMSEA = .11, 90% CI [.09, .14]). In contrast, the two-factor model provided good fit to the data ($\chi^2 = 44.66$, $df = 34$, $p = .10$, CFI = .98, RMSEA = .05, 90% CI [.00, .08]). Moreover, the two-factor model fit the data significantly better than the one-factor model ($\Delta\chi^2 = 173.98$, $\Delta\ df = 1$, $p < .001$). The bifactor model did not converge as it is, and as such PSWQ-B item 3 ("When I am under pressure, I worry a lot") was set to load only on the general factor but not the specific worry factor. The bifactor model provided good fit to the data ($\chi^2 = 27.81$, $df = 25$, $p = .32$, CFI = 1.00, RMSEA = .003, 90% CI [.000, .08]). Moreover, the bifactor model fit the data significantly better than the two-factor model ($\Delta\chi^2 = 16.74$, $\Delta\ df = 8$, $p < .05$). In addition, bifactor indices supported the unidimensionality of the PT construct (ECV = .68, PUC = .64, $\text{Omega}_H = .77$, $\text{Omega}_{\text{Worry}} = .28$, $\text{Omega}_{\text{Rumination}} = .40$; see Table 2, Panel 2).

Measurement invariance by biological sex

As the bifactor model did not fit better than the two-factor model in males, the two-factor model fit the data well in females, and bifactor indices suggested the presence of unidimensionality in females, measurement invariance was examined between males and females in the two-factor model. All steps of the measurement invariance process and their corresponding model parameters are displayed in Table 2. First, as configural invariance acts as a baseline model, the two-factor model was tested with no constraints on factor loadings or intercepts. The configural model provided good fit to the data ($\chi^2 = 71.62$, $df = 68$, $p = .36$, CFI = 1.00, RMSEA = .02, 90% CI [.00, .05]). Metric invariance was tested by constraining factor loadings to equality between groups. The model testing metric invariance provided good fit to the data ($\chi^2 = 76.94$, $df = 76$, $p = .45$, CFI = 1.00, RMSEA = .01, 90% CI [.00, .05]). In addition, there was a non-significant difference between the model testing metric invariance and the configural model ($\Delta\chi^2 = 4.93$, $\Delta\ df = 8$, $p = .76$); thus, metric invariance was met. Following this, scalar invariance was tested by constraining intercepts to equality between groups. This model provided adequate fit to the data ($\chi^2 = 99.54$, $df = 84$, $p = .12$, CFI = .98, RMSEA = .04, 90% CI [.00, .06]). Model fit comparisons revealed a significant difference between the model testing scalar invariance and the model testing metric invariance ($\Delta\chi^2 = 22.74$, $\Delta\ df = 8$, $p < .01$); thus, scalar invariance was not met. Modification indices were examined to determine if freeing any item intercepts would allow partial scalar invariance to be met. Based on modification indices, freeing any of the intercepts across sexes would not have led to significantly better fit; thus, scalar invariance was not met in the present sample.

Two-factor SEM examining associations rumination and worry share with MDD and GAD diagnoses

The two-factor model with partial scalar invariance in males and females was included in an SEM examining MDD and GAD as outcomes (see Figure 1). Wald χ^2 comparisons were used to investigate if associations differed as a function of biological sex by constraining paths from the Worry and Rumination factors to the MDD and GAD outcomes to equality. The SEM model provided good fit to the data ($\chi^2 = 127.84$, $df = 116$, $p = .21$, CFI = .99, RMSEA = .03, 90% CI [.000, .05]). In females, worry was positively associated with GAD diagnoses ($B = .21$, $p < .001$, OR = 1.23, 90% OR = 1.14, 1.34). There was a positive association between rumination and MDD diagnoses ($B = .24$, $p < .001$, OR = 1.27, 90% OR = 1.13, 1.45). After the Benjamini–Hochberg correction, there were no other significant associations between rumination or worry with GAD or depression diagnoses. In females, rumination and worry accounted for 19.6% and 21.4% of the variance in MDD diagnoses and GAD diagnoses, respectively. After the Benjamini–Hochberg correction, there were no significant associations between worry or rumination in males. In males, rumination and worry accounted for 22.5% and 10.4% of the variance in MDD diagnoses and GAD diagnoses, respectively (see Figure 2). There was a significant difference in the association between worry and GAD diagnoses ($\chi^2 = 4.38$, $p < .05$), and a trend level difference between worry and MDD diagnoses ($\chi^2 = 3.29$, $p = .07$) across sexes. In all comparisons listed prior, the association was significantly stronger in females compared to males. There were no other significant differences between the sexes ($p > .10$).

DISCUSSION

The present study extends previous research showing differences in rumination and worry across sexes. After correcting for multiple tests, worry and rumination were only associated with MDD and GAD, respectively, in women but not men. Moreover, the association between worry and diagnoses of GAD and MDD were significantly stronger in women compared to men.

The findings that worry was more strongly associated with GAD in females, compared to males, is consistent with previous studies demonstrating that females report higher levels of trait worry and

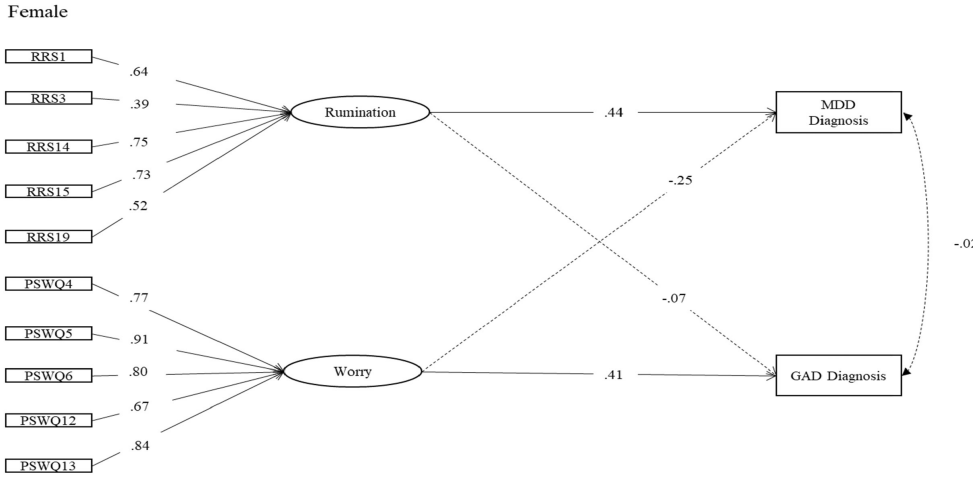

FIGURE 1 SEM of rumination and worry predicting GAD diagnoses and MDD diagnoses, in females. RRS = Brief-Ruminative Response Scale. PSWQ = Penn State Worry Questionnaire. Solid lines indicate significant associations. Dashed lines indicate non-significant associations. All associations are represented by non-standardized associations. All factor loadings are standardized. All significant associations are significant after Benjamini–Hochberg corrections for significance.

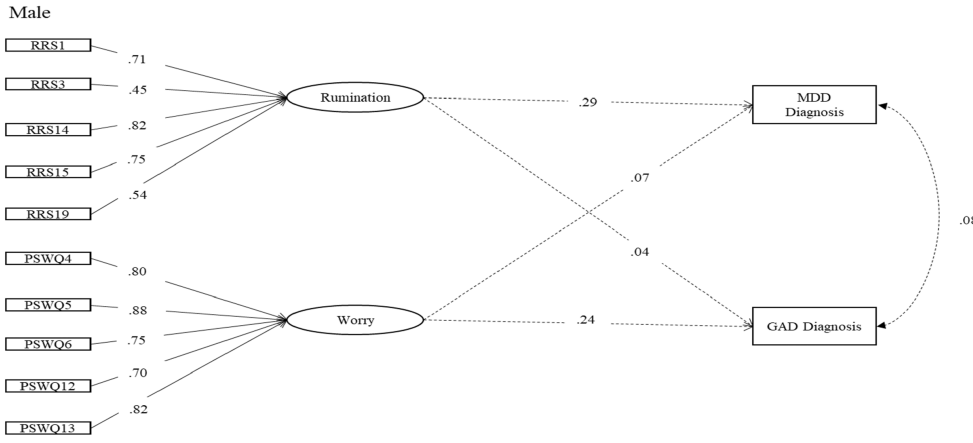

FIGURE 2 SEM of rumination and worry predicting GAD diagnoses and MDD diagnoses, in males. RRS = Brief-Ruminative Response Scale. PSWQ = Penn State Worry Questionnaire. Solid lines indicate significant associations. Dashed lines indicate non-significant associations. All associations are represented by non-standardized associations. All and factor loadings are standardized. All significant associations are significant after Benjamini–Hochberg corrections for significance.

receive anxiety disorder diagnoses at a higher rate compared to males (McLean et al., 2011; Robichaud et al., 2003). These results add to a growing body of literature that has demonstrated marked sex differences in the development and maintenance of anxiety disorders, especially regarding differences in cognitive risk factors such as worry (Robichaud et al., 2003) and rumination (Johnson & Whisman, 2013). The stronger association between worry and GAD diagnoses in females compared to males suggests that worry may not be as good of a marker for GAD diagnoses in males compared to females. It could also suggest that males do not self-report worry as reliably as females, which would be captured by an attenuated association such as ours. More research is needed to determine which factors account for the lower concordance between worry and GAD diagnoses in males compared to females as this could have implications for diagnosis and treatment of GAD in males.

The present study is the first to investigate sex differences in the bifactor model of PT. Although past research has demonstrated that a bifactor model fit best overall (e.g., Spinhoven et al., 2018), the present study was the first to demonstrate that the structure of PT differs across sexes. In addition, our examination of bifactor indices in females revealed that, even in the bifactor model, the construct of PT appeared to best be represented as a multidimensional construct. In other words, although rumination and worry appear to fall under the umbrella of PT, they also appear to be distinct constructs. These findings are consistent with previous factor analytic studies that have found that worry and rumination are distinct factors (e.g., Fresco et al., 2002; McEvoy & Brans, 2012), as well as previous studies using bifactor modelling of PT that have found that rumination and worry influence psychopathology above and beyond that of a general PT factor (Hur et al., 2017; Samtani et al., 2021). In addition, one possible explanation for these findings is that mean level differences in lower-order constructs such as rumination and worry are being driven by structural differences in PT broadly. For example, although past research has demonstrated that rumination, worry and PT broadly are all higher in women relative to men, these findings may be due to overlapping variance and the shared PT component between all three constructs. It should be noted, however, that these findings should be replicated in future work to investigate how robust the structural differences are in PT across men and women.

Our findings do run counter to the results of a study by Spinhoven et al. (2018) in which a bifactor model fit the data best for PT and the general factor of PT accounted for most of the variance in symptoms of depression and anxiety. There are several possible explanations for the differences between the results of this study and our findings. First, the general factor created by Spinhoven et al. (2018) included rumination, worry and a general measure of PT. It possible that our exclusion of a general measure of PT in the higher-order PT factor may have resulted in more distinctive

lower-order factors. However, if this were the case, lower-order factors capturing items specific to worry and rumination could have still emerged if present in the data of Spinhoven et al., which is supported by the rumination and worry items loading onto the specific factor of rumination and worry. It is possible that our sample being a sample at-risk for suicide by virtue of elevated risk for emotional distress risk factors (90.6% met for a DSM-5 disorder) may contribute to these differences given Spinhoven et al. used a community sample. Our findings also align with extant literature demonstrating that rumination and worry appear to be more distinct from PT in clinical versus community samples (e.g., Ehring et al., 2011).

Our findings may have clinical implications for diagnoses of GAD in men versus women. Our findings that worry was more strongly associated with GAD diagnoses in women but not men highlight the possibility that whereas worry may be sufficient for diagnosing GAD in women, it may be an insufficient criterion for diagnosing GAD in men, whereas more physiological symptoms (e.g., restlessness and agitation) may be more predictive of anxiety disorders in men. These findings also align with evidence that women are more likely to develop anxiety disorders (e.g., McLean et al., 2011) compared to men and may be partially driven by an increase in the association between worry and GAD diagnoses in women relative to men.

Limitations

There were several limitations of the present study that should be noted. First, short-form versions of worry (PSWQ-brief) and rumination (RRS-brief) measures were utilized in this investigation. Although the psychometric properties of the PSWQ-brief have been formally established and determined to be excellent within this sample, this short form is inferior to the full PSWQ in its ability to identify individuals with pathological worry (Wuthrich et al., 2014). Similarly, RRS-brief measures depressive rumination specifically. Although the abbreviated versions of both measures have been determined to be valid instruments for the screening of worry and rumination (Topper et al., 2014), it is possible that the removal of items from the full versions of these measures resulted in less precise measurement of these domains within this sample (Shrout & Yager, 1989). More specifically, it is possible that the use of short forms in our study may have artificially inflated the relatedness within the construct and deflated the relatedness between the two constructs due to these short forms being created specifically through isolation of items that were most related among PSWQ and RRS items, respectively (Topper et al., 2014). Second, given the cross-sectional design of this investigation, it is unclear if the differences in the association between rumination, worry, GAD and MDD differs across time points, and these findings should be replicated in a longitudinal design. Another limitation is that our study was conducted in a community sample at risk for suicide, and thus these findings may not generalize to less severe samples. There has been evidence to suggest that worry and rumination appear more distinct from PT when measured in clinical versus community samples (Ehring et al., 2011). Although this sample was not a clinical sample per se, the elevated rates of risk factors for anxiety disorders and diagnoses of psychopathology suggest that levels of psychopathology are similar to clinical samples. With this in mind, rumination and worry may have presented as more unique in this sample compared to a less severe sample. Finally, our study is limited in that it focuses solely on self-reported symptoms and diagnoses based on these symptoms in an interview, which may have led to amplified associations due to method bias (Paulhus & Vazire, 2007). It is crucial to extend this research by investigating the role that worry and rumination play with other correlates of psychopathology, such as neurophysiological or biological markers.

Conclusion

The present study extends research on the multidimensionality of PT, finding that rumination and worry appear to be unique, correlated constructs that underlie an overarching PT construct. The present study also extends research on sex differences in the structure of PT, and the degree to which sex differences may

moderate the impact the association between cognitive risk factors and internalizing disorders. We found that women and men differed in their association between worry and both diagnoses of GAD, with women having a stronger association compared to men. These findings contribute to a large body of evidence that has investigated the higher-order structure of PT by examining sex differences in the constructs, investigating these constructs in a high-risk community sample, and using multiple units of analysis to investigate these differences. Taken together, these findings highlight the multidimensionality of PT, the degree to which this construct may be impacted by gender, and the impact that this construct has on neurophysiological indicators of psychopathology. As this study is the first to directly assess structural differences in PT across sexes, it is crucial that these findings are replicated in future work.

AUTHOR CONTRIBUTIONS

Brandon Koscinski: Data curation; writing – original draft; writing – review and editing. **Catherine Accorso:** Methodology; writing – original draft; writing – review and editing. **Brian Albanese:** Methodology; writing – original draft; writing – review and editing. **Norman B. Schmidt:** Conceptualization; data curation; funding acquisition; investigation; project administration; supervision. **Nicholas P. Allan:** Conceptualization; formal analysis; supervision; validation; writing – original draft; writing – review and editing.

CONFLICT OF INTEREST STATEMENT

All authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data for this project is available upon request.

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