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A bifactor approach to modeling the structure of repetitive thinking: Replication and extension

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ABSTRACT

Recent research found that a bifactor structure provides the best fit for maladaptive repetitive thinking. The present research attempted to: (a) replicate this finding with an alternative measure of rumination; and (b) to extend it by testing the best fitting model including both adaptive and maladaptive repetitive thinking using the Penn State Worry Questionnaire and the Rumination and Reflection Questionnaire. Using data from 14 independent datasets (N = 4711), the fit of three worry and rumination models and five worry, rumination, and reflection models were compared. The validity of the latent factors of the best fitting model of worry, rumination, and reflection was examined with several factor integrity tests and by examining their associations with theoretically relevant constructs. Results indicate that a bifactor structure provides the best fit for worry, rumination, and reflection. Furthermore, four orthogonal factors derived from the bifactor model showed diverging associations with distress, personality, emotion regulation, emotional awareness, and intolerance of uncertainty.

1. Introduction

Repetitive thinking refers to "repetitive, prolonged, and recurrent thoughts about one's self, one's concerns, and one's experiences" (Watkins, 2008, p. 163). Some forms of repetitive thinking (e.g., reflection, which focuses on curious self-examination) are typically associated with pleasant or neutral affect and are generally considered adaptive. In contrast, other forms (e.g., rumination, worry) are typically associated with unpleasant affect and are generally considered maladaptive (Segerstrom et al., 2003; Watkins, 2008). For example, reflection is generally considered adaptive because it promotes rehearsal of future behavior, emotional processing of negative life events, and creativity (Hao et al., 2016; Segerstrom et al., 2003), whereas rumination is generally considered maladaptive because it is associated with dysfunctional attitudes, dependency, and neuroticism (Nolen-Hoeksema et al., 2008). Unpleasant repetitive thinking has been shown to be a transdiagnostic phenomenon that is particularly important for understanding the development of emotion-related psychopathology (Watkins, 2008).

Worry and rumination are both characterized by streams of negatively-valenced thoughts and images. Because of their similarities (e.g., McEvoy & Brans, 2013), some researchers have gone so far as to treat worry and rumination as indistinguishable components of perseverative thinking (Ruscio et al., 2011). Despite their similarities, they are not identical. In fact, some clients present with worry and not rumination, whereas others present with rumination and not worry. It is therefore important to understand not only their similarities, but also their unique features. Two features that distinguish worry and rumination are the content and temporal focus of the thoughts. Worry involves thoughts about possible future negative events and overestimation of the likelihood of negative outcomes as a result of uncertain situations (Berenbaum, 2010). In contrast, the content of ruminative thoughts are self-referential and revolve around themes of loss or failure (Nolen-Hoeksema, 1991).

Hur et al. (2017) compared the fits of several possible structures of worry and rumination that differed in the hypothesized relations between the two. They tested three models: (a) a single-factor model representing worry and rumination as a single unitary phenomenon; (b) a two-factor model representing worry and rumination as two correlated, but distinct phenomena; and (c) a bifactor model representing worry and rumination as having both shared and unique properties. The bifactor model contained a negative repetitive thinking latent factor that

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captured the common variance of worry and rumination items, and uncorrelated worry and rumination latent factors that captured the unique variance left over by the negative repetitive thinking factor. In comparison to both the single-factor and the two-factor model, the bifactor model provided a better fit.

As part of their research on the role of executive functioning and negative repetitive thinking, Madian et al. (2019) replicated the finding that a bifactor structure provides the best fit for worry and rumination. Although Madian et al. (2019) replicated this finding, they measured worry and rumination with the same instruments as did Hur et al. (2017), which makes it difficult to discern if the findings replicated because: (a) a bifactor structure provides a good fit for the worry and rumination *instruments* that both studies used; or (b) a bifactor structure provides a good fit for the *constructs* of worry and rumination regardless of how they are measured. Thus, one of the goals of the present research was to test whether the findings of Hur et al. (2017) and Madian et al. (2019) would replicate when using an alternative measure of rumination. Hur et al. (2017) and Madian et al. (2019) measured rumination using the rumination subscale of the Rumination and Reflection Questionnaire, a scale commonly used to measure rumination. In the present research, we also used the Response Style Questionnaire, another commonly used scale, particularly among psychopathology researchers (Joormann, 2006; McEvoy & Brans, 2013; Spasojević & Alloy, 2001). In comparison to the rumination subscale of the RRQ, which captures a tendency to think about negative aspects of the self and about regrets, the RSQ captures a tendency to think about symptoms related to depression and about the consequences of those symptoms.

Another goal of the present research was to extend the bifactor structure of repetitive thinking to include both unpleasant and pleasant repetitive thinking. Understanding the ways in which unpleasant repetitive thinking may be similar to or different from pleasant repetitive thinking is important because it can provide insight into the links between repetitive thinking and both desirable and undesirable outcomes (e.g., well-being, depression). Therefore, in addition to examining worry and rumination, we also measured reflection. We tested the fit of five different models, which are depicted in Fig. 1. The single-factor model is composed of a single latent factor that accounts for all of the variance of the worry, rumination, and reflection items. This model proposes that worry, rumination, and reflection are different presentations of a common process that is characterized by repetitive thought. The content-specific model posits that worry, rumination, and reflection are distinct, but correlated, latent factors, and that each latent factor accounts for the variance of their respective construct items. The valence model hypothesizes that unpleasant repetitive thinking and pleasant repetitive thinking are two distinct, but correlated constructs, and that the unpleasant repetitive thinking factor accounts for all of the variance of the worry and rumination items. Similar to the single-factor model, the valence model proposes that worry and rumination are presentations of a common process (unpleasant repetitive thinking), but unlike the single-factor model, the valence model proposes that reflection and unpleasant repetitive thinking are fundamentally unique constructs. The valence bifactor model is composed of four latent variables: negative repetitive thinking (a general factor that accounts for the common variance of worry and rumination), worry-specific, rumination-specific, and pleasant repetitive thinking. The worry-specific and rumination-specific factors represents the left-over variance of the negative repetitive thinking factor and are not correlated with one another. The pleasant repetitive thinking factor accounts for the variance of the reflection manifest variables and is correlated with the negative repetitive thinking factor. Similar to the valence model, the valence bifactor model proposes that unpleasant and pleasant repetitive thinking are unique constructs, but unlike the valence model, the valence bifactor model suggests that worry and rumination share common variance, but also have unique characteristics. The content-specific bifactor model is composed of one general latent factor that accounts for the common variance of repetitive thinking and three uncorrelated latent factors: worry-specific, rumination-specific, and reflection-specific. The content-specific bifactor model proposes that worry, rumination, and reflection are presentations of a shared common process (repetitive thinking), but that they also possess unique characteristics. Based on the expectation that all forms of repetitive thinking share at least some variance in common, we predicted that of the five models, the content-specific bifactor model would have the best fit.

In addition to extending past research by examining the structure of both unpleasant and pleasant repetitive thinking, we extended past research by examining the relation between repetitive thinking latent factors and a much broader range of theoretically relevant constructs than previous research had examined. This was important because it enabled us to test the validity of the factors in the best fitting model, and to understand what those factors are measuring. We examined three broad types of constructs. First, we examined two types of distress constructs that have been found to be associated, but not redundant with, rumination and worry: depression and anxious arousal (Nolen-Hoeksema et al., 1998; Vasey et al., 2017). Second, we examined the big five personality dimensions. We examined personality dimensions because previous research has consistently found associations between dimensions such as neuroticism, extraversion, and conscientiousness and rumination and worry (Friedman & Kern, 2014). Finally, we examined a variety of constructs that have been found to be associated with numerous forms of distress, focusing on emotion regulation, emotional awareness, and intolerance of uncertainty (Berenbaum et al., 2008; Joormann & Vanderlind, 2014; Thompson et al., 2009).

2. Methods

2.1. Participants

The data analyzed for this paper came from 14 datasets.[1] Item-level data regarding worry and rumination were available for 4711 participants. Self-reported demographic data were available at the dataset level for 194 participants, and were available at the individual level for 3122 participants (and were unavailable for 1395 participants). Based on the available self-reported demographic data, we estimate that 58% were female, and age ranged from 18 to 28 years ($M = 18.9$; $SD = 1.1$). Of the 3034 who provided information concerning race/ethnicity, 68% reported being European American, 17% reported being Asian or Asian American, 8% reported being African American, and 7% reporting being other racial groups. Of those people who reported ethnicity, 9% reported being Latinx.

2.2. Instruments

2.2.1. Worry

Across all samples (N = 4711), worry was measured using the 16-item Penn State Worry Questionnaire (PSWQ; Meyer et al., 1990). An example item is "My worries overwhelm me." Past research suggests that the PSWQ has excellent test-retest reliability and good convergent and discriminant validity (e.g., Meyer et al., 1990; Nitschke et al., 2001). Internal consistency in the present (combined) sample was excellent: $\omega_t = 0.95$, $\alpha = 0.94$.

2.2.2. Rumination

Individual differences in ruminative tendencies were measured using the 12-item subscale form the Rumination and Reflection Questionnaire (RRQ; Trapnell & Campbell, 1999) (N = 3600) and the Response Style Questionnaire (RSQ; (Nolen-Hoeksema & Morrow, 1991) (N = 1896). The RRQ (Trapnell & Campbell, 1999) rumination subscale assesses the degree to which individuals think repetitively about past life events.

[1] In addition to data collected by the authors, data analyzed were also provided by several researchers listed in the acknowledgements section.

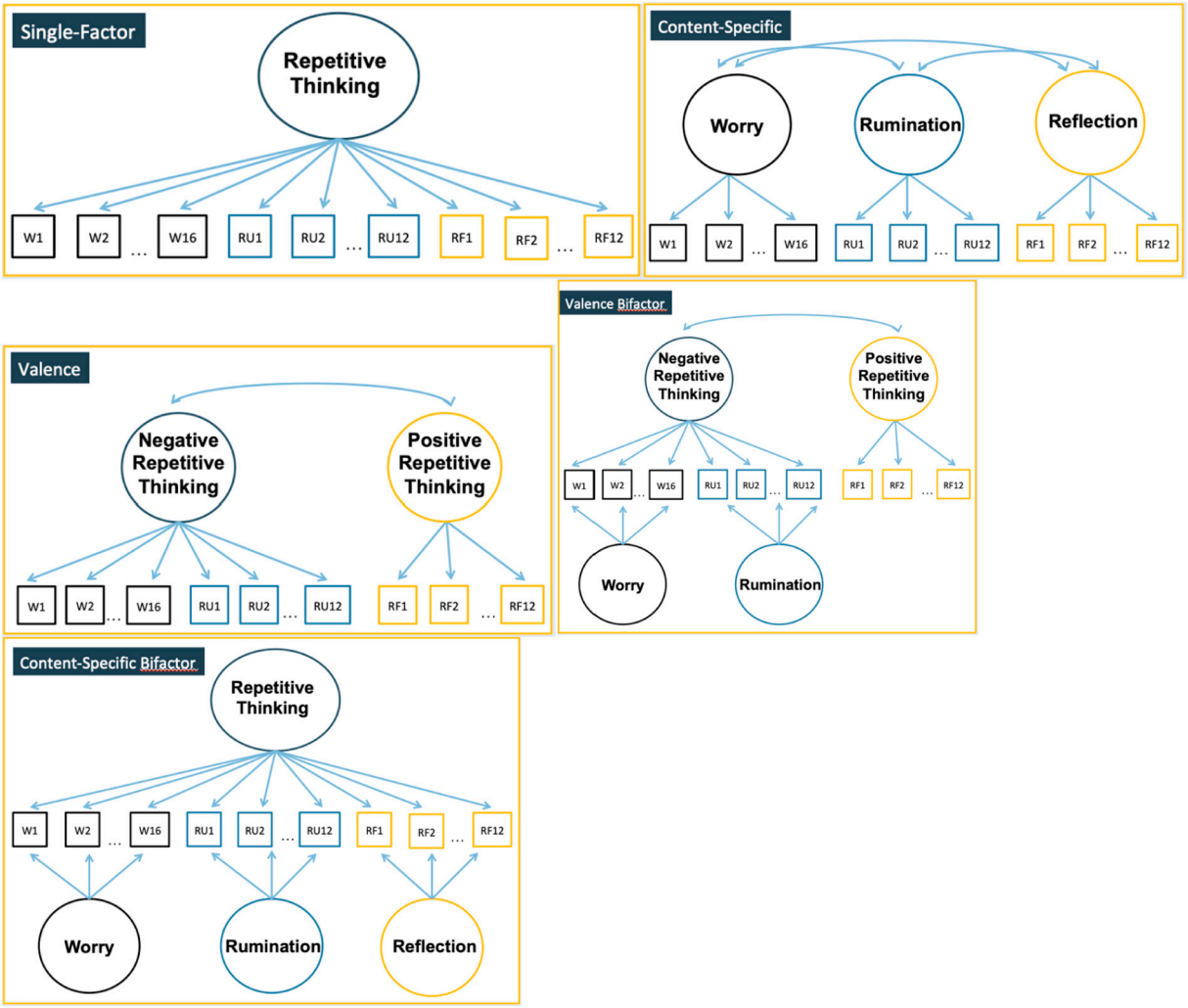

Fig. 1. Confirmatory factor analysis models representing relations between worry, rumination, and reflection.

Participants rated how each of 12 rumination statements described them (e.g., "I tend to ruminate or dwell over things that happened to me for a really long time afterward") on a scale from 1 ("strongly disagree") to 5 ("strongly agree"). Internal consistency in the present sample was excellent: $\omega_t = 0.93$, $\alpha = 0.91$.

The RSQ is composed of 22 items that measure the degree to which participants repetitively think about their depressed mood. Participants rated items to indicate how they generally respond "When [they] feel sad, down, or depressed…" on a scale from 1 ("almost never") to 4 ("almost always"). An example item is "think about how alone I feel." Internal consistency in the present sample was excellent: $\omega_t = 0.94$, $\alpha = 0.92$.

2.2.3. Reflection

Individual difference in reflective tendencies were measured using the 12-item subscale from the RRQ (N = 1638). The reflection subscale of the RRQ measures the degree to which individuals tend to introspect in a curious manner. Participants rated how each of 12 rumination statements described them (e.g., "I love analyzing why I do things") on a scale from 1 ("strongly disagree") to 5 ("strongly agree"). The Rumination and Reflection subscales were weakly positively correlated, $r = 0.10$, $p = .01$. Internal consistency in the present sample was excellent: $\omega_t = 0.90$, $\alpha = 0.86$.

2.2.4. Anhedonic depression

Anhedonic depression was measured using the 8-item version (though the suicide item was not administered due to IRB concerns) of the anhedonic depression subscale from the Mood and Anxiety Symptom Questionnaire (MASQ; Watson, Weber, et al., 1995) (N = 270). The MASQ was developed as an instrument that would distinguish between anxiety and depression. An example item is "Felt withdrawn from people." Bredemeier et al. (2010) found that the 8-item version was superior to the full 22-item version for screening for current MDD. Internal consistency in the present sample was very good: $\omega_t = 0.90$, $\alpha = 0.85$.

2.2.5. Anxious arousal

Anxious arousal was measured using the 17-item anxious arousal subscale from the MASQ (MASQ; Watson, Weber, et al., 1995) (N = 270). An example item is "Heart was racing or pounding." Past research has indicated that the anxious arousal subscale of the MASQ has good convergent and discriminant validity (Nitschke et al., 1999; Nitschke et al., 2001; Reidy & Keogh, 1997; Watson, Clark, et al., 1995). Internal consistency in the present sample was very good: $\omega_t = 0.89$, $\alpha = 0.87$.

2.2.5.1. Personality. Participants provided information concerning each facet of the Big Five by completing the 50-item version of the International Personality Item Pool (International Personality Item Pool, 2001; N = 270). There are 10 items for each of the five personality subscales: neuroticism (e.g., "Get stressed out easily"); extraversion (e.g., "Talk to a lot of different people at parties"); openness (e.g., "Spend time reflecting on things"); agreeableness (e.g., "Sympathize with

others' feelings"); conscientiousness (e.g., "Am always prepared"). These scales have been found to have good psychometric properties and reasonable evidence of convergent and discriminant validity (Goldberg, 1999; Lim & Ployhart, 2006). Internal consistencies in the present sample were: neuroticism: $\omega_t = 0.89$, $\alpha = 0.86$; extraversion: $\omega_t = 0.93$, $\alpha = 0.90$; openness: $\omega_t = 0.86$, $\alpha = 0.80$; agreeableness: $\omega_t = 0.86$, $\alpha = 0.82$; conscientiousness: $\omega_t = 0.81$, $\alpha = 0.75$.

2.2.6. Emotional attention and clarity

Attention to emotion and clarity of emotion were measured using relevant subscales of the Trait Meta-Mood Scale (TMMS; Salovey et al., 1995) and of the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2003). The 13-item TMMS attention to feelings subscale (e.g., "I often think about my feelings;" N = 266) and the 6-item DERS lack of emotional awareness subscale (e.g., "I pay attention to how I feel;" N = 138) assess the amount of awareness and thought that individuals allocate to their emotions. Internal consistency in the present study were: TMMS attention to feelings: $\omega_t = 0.88$, $\alpha = 0.90$; DERS lack of emotional awareness: $\omega_t = 0.87$, $\alpha = 0.83$. The 10-item TMMS clarity of feelings subscale (e.g., "I am rarely confused about how I feel;" N = 267) and the 5-item DERS lack of emotional clarity (e.g., "I have no idea how I am feeling;" N = 138) assess the degree to which individuals are able to understand and identify their feelings. Internal consistency in the present study were: TMMS clarity of feelings: $\omega_t = 0.85$, $\alpha = 0.80$; DERS lack of emotional clarity: $\omega_t = 0.85$, $\alpha = 0.82$. To be consistent with the TMMS, both the DERS lack of emotional awareness and lack of emotional clarity scores were reverse coded to so that higher scores represent higher attention to emotion and clarity of emotion. Self-reported measures of attention to emotion and clarity of emotion, including the TMMS, have been found to be associated with scores on other self-report questionnaires in theoretically predicted ways (Gohm & Clore, 2002), as well as with behavioral/performance-based measures (e.g., Coffey et al., 2003; Dizén et al., 2005).

2.2.7. Emotion regulation

Different emotion regulation facets were measured using relevant subscales of the DERS. Specifically, restricted emotion regulation response options (limited strategies) was assessed with the 8-item limited access to emotion regulation strategies subscale (e.g., "When I'm upset, I believe that wallowing in it is all I can do;" N = 137); rejection of affective responses (emotion nonacceptance) was measured with the 6-item nonacceptance of emotional responses subscale (e.g., "When I'm upset, I become embarrassed for feeling that way;" N = 138); inability to direct thoughts and behavior towards productive ends (limited goal behavior) was measured with the 5-item difficulty engaging in goal-directed behavior subscale (e.g., "When I'm upset, I have difficulty getting work done;" N = 137); and engagement in unplanned thoughts and behavior (impulsivity) was measured with the 6-item impulse control difficulties subscale (e.g., "When I'm upset, I lose control over my behavior;" N = 138). Internal consistencies in the present sample were: limited access to emotion regulation strategies: $\omega_t = 0.91$, $\alpha = 0.87$; nonacceptance of emotional responses: $\omega_t = 0.92$, $\alpha = 0.86$; difficulty engaging in goal-directed behavior: $\omega_t = 0.90$, $\alpha = 0.87$; impulse control difficulties: $\omega_t = 0.89$, $\alpha = 0.85$.

2.2.8. Intolerance of uncertainty

Individual differences in intolerance of uncertainty were measured using the Intolerance of Uncertainty Scale-12 (IUS-12; Shihata et al., 2018), which is an abbreviated version of the original 27-item IUS (Buhr & Dugas, 2002). An example item is "Uncertainty keeps me from living a full life." Internal consistency in the present sample was very good: $\omega_t = 0.89$, $\alpha = 0.87$.

3. Analytic strategy

3.1. Replication analyses

We first tested whether the results of Hur et al. (2017) and Madian et al. (2019) would replicate when using the same instruments that they used (N = 2091[2]). We then tested whether the results would replicate when using the RSQ rather than the RRQ to measure rumination (N = 2256). To do so, we used confirmatory factor analysis (CFA) to test the fit of a single-factor, two-factor, and a bifactor model, the three models previously tested by Hur et al. (2017). Model fit was evaluated using commonly used fit indices: the chi-square (χ^2) fit statistic, the comparative fit index (CFI), and the root mean square error of approximation (RMSEA). CFI values greater than 0.95 (Hu & Bentler, 1999) and RMSEA values less than 0.08 indicate a good fit to the data, while values less than 0.05 indicate a very good fit (Hooper et al., 2008). Models were fit using the lavaan package in R (Rosseel, 2012), treating the data as ordered categorical data using a weighted least squares estimator (Muthén, 1984). This was done to accommodate the likelihood of non-equal interval lengths in the Likert-scaled data. The χ^2 difference test was used to directly compare the three proposed models and identify the best fitting model. We conducted these analyses using the lavaan package in R (Rosseel, 2012).

3.2. Extension analyses

We used CFA again to test the fit of the five models of worry, rumination, and reflection depicted in Fig. 1 (N = 2428). We used the same fit indices we used to test the fit of the replication models to evaluate the fit of the extension models. We conducted these analyses using the lavaan package in R (Rosseel, 2012).

3.3. Factor validity analyses

Once the best fitting model was identified that included worry, rumination, and reflection, we computed the explained common variance (ECV), construct replicability (H), and the percentage of systematic variance that can be attributed to individual differences by the general factor (ω_H). According to Dueber (2017), when a ω_H score of a factor is high (>0.80), that factor can be considered unidimensional and a high H value (>0.80) suggests a well-defined latent variable.

We used a structural equation modeling (SEM) approach to evaluate the descriptive validity of the factors by estimating the associations between the factors (derived from the best fitting model) and theoretically relevant constructs (i.e., depression, anxious arousal, personality, emotion regulation, emotional awareness, and intolerance of uncertainty). This approach has several advantages. First, because the factors are modeled as latent variables, the measurement errors were controlled for, maximizing the effect sizes with relevant constructs. Second, since the structural modeling approach allowed for missing data with categorical data using a pairwise present approach, both the information obtained from the sample and the sample size were maximized (N = 2428)[3], yielding more accurate parameter estimates than listwise deletion (Asparouhov & Muthén, 2010). Third, by examining a broad range of correlates, we are able to better understand what the factors from the best fitting model appear to be measuring. All analyses were conducted using the lavaan package in R (Rosseel, 2012).

[2] The data from Hur et al. (2017) were not used in this analysis to insure that the replication would be completely independent.

[3] Although $N = 2428$ was used to estimate factor scores, the participants who completed the constructs used to evaluate descriptive validity came from two samples ($N = 142$, $N = 128$).

4. Results

4.1. Replication results

We began by attempting to replicate the finding as measured by the RRQ of Hur et al. (2017) and Madian et al. (2019) that a bifactor model would provide a better fit accounting for the relation between worry (as measured by the PSWQ) and rumination (as measured by the RRQ) than would alternative models. As expected and can be seen in Table 1, the fit of the bifactor model was good and was significantly superior to the fit of the alternative models. Specifically, the two-factor model provided a better fit to the data than a single-factor model, $\Delta X^2(1) = 12{,}275.56$, $p < .001$, and the bifactor model in turn improved the fit to the two-factor structure, $\Delta X^2(27) = 1491.74$, $p < .001$.

Next, we tested whether a bifactor structure of unpleasant repetitive thinking would provide the best fit when using a different measure of rumination than that used by Hur et al. (2017), namely, the RSQ. As can be seen in Table 2, as expected, a bi-facture structure of unpleasant repetitive thinking provides the best fit in comparison to alternative models when using the RSQ. Specifically, the two-factor model provided a better fit to the data than a single-factor model, $\Delta X^2(1) = 25{,}538.6$, $p < .001$, and the bifactor model in turn improved the fit to the two-factor structure, $\Delta X^2(37) = 12{,}186.74$, $p < .001$.

4.2. Extension results

We then attempted to extend the bifactor structure of repetitive thinking to include both unpleasant repetitive thinking and pleasant repetitive thinking. For the extension analyses (i.e., all analyses that include reflection), rumination was measured with the RRQ. We tested the fit of five different models: a single factor model, a content-specific model, a valence model, a content-specific bifactor model, and a valence bifactor model (see Fig. 1). As displayed in Table 3, the single factor model and the valence model both had poor fit. In contrast, the content-specific and the valence bifactor models had modest fit, and the content-specific model had good fit. The content-specific bifactor model was superior to the fit of the alternative models. Specifically, the content-specific model provided a statistically significant better fit to the data than a single-factor model, $\Delta X^2(3) = 35{,}419.8$, $p < .001$, the valence bifactor model in turn improved fit to the content-specific model, $\Delta X^2(26) = 1163.1$, $p < .001$, and the content-specific bifactor model in turn improved fit to the valence bifactor structure (model with the next best fit) $\Delta X^2(11) = 2302.6$, $p < .001$.

4.3. Factor validity results

Given that the content-specific bifactor model had the best fit, we present the factor loadings in Table 4. Worry items tended to load strongly on the general repetitive thinking factor (loadings ranging from 0.29 to 0.66; $M = 0.55$) and on the worry-specific factor (loadings ranging from 0.31 to 0.61; $M = 0.51$). Relative to worry items, rumination items had higher loadings on the general repetitive thinking factor (loadings ranging from 0.60 to 0.78; $M = 0.66$), but lower loadings on the specific factor (i.e., rumination-specific) (loadings ranging from −0.08 to 0.68; $M = 0.34$). Relative to worry and rumination items, reflection items had substantially lower loadings on the general repetitive thinking factor (loadings ranging from −0.14 to 0.24; $M = 0.06$). In contrast, reflection items had higher loadings on the specific factor (i.e., reflection-specific) than did both the worry and rumination items on their respective specific factors.

The general repetitive thinking factor explained approximately 48% of the common variance of worry, rumination, and reflection items. Similarly, the worry-specific ($ECV = 0.28$) and reflection factors ($ECV = 0.38$) were modestly strong in their ability to explain the variance of their respective items relative to all explained variance. In contrast, the rumination-specific factor explained only 13% of the variance of rumination items relative to all explained variance. In addition to the low variance-explaining power, the rumination-specific factor scored poorly on two other tests of factor integrity. Specifically, all of the latent factors except for the rumination factor were well defined and highly replicable: repetitive thinking ($H = 0.95$), worry ($H = 0.87$), rumination ($H = 0.72$), and reflection ($H = 0.91$). The rumination-specific factor was only able to explain a small proportion of the variance due to individual differences after accounting for the variance explained by the general factor ($\omega_H = 0.10$). In contrast, the worry-specific ($\omega_{HS} = 0.32$) and the reflection-specific ($\omega_{HS} = 0.40$) factors were able to explain a modest proportion of the variance due to individual differences after accounting for the variance explained by the general factor. In comparison to the specific factors, the general repetitive thinking factor was able to explain the most systematic variance that can be attributed to individual differences ($\omega_{HS} = 0.64$).

Last, we tested the structural associations between the PSWQ/RRQ factors with theoretically expected constructs, which can be found on Table 5. The general repetitive thinking factor was positively associated with a larger number of undesirable constructs (e.g., anhedonic depression, neuroticism) than were the worry-specific, rumination-specific, and reflection-specific factors. The general repetitive thinking factor was the only factor that was positively associated with all facets of poor emotion regulation and with anhedonic depression. Additionally, this factor was positively associated with neuroticism.

The rumination-specific and the worry-specific factors were associated very differently with the other constructs. Whereas the worry-specific factor was positively associated with neuroticism, conscientiousness, and intolerance of uncertainty, the rumination-specific factor was not. Whereas the rumination-specific factor was strongly positively associated with emotion nonacceptance, the worry-specific factor was not. The pattern for the reflection-specific factor was different than the other three factors. Unlike the rest of the factors, the reflection-specific

Table 1
Goodness of fit statistics for alternative models of the PSWQ/RRQ (rumination).

Model	X^2	df	X^2/df	CFI	RMSEA
Single-factor model	15,618.34	350	44.62	0.95	0.15
Two-factor model	3342.78	349	9.58	0.99	0.07
Bi-factor model	1851.04	322	5.75	1.00	0.05

Note. N = 2091. X^2 = chi-square goodness of fit statistic; df = degrees of freedom; CFI = comparative fit index; RMSEA = root mean square error of approximation.

Table 2
Goodness of fit statistics for alternative factor models of the PSWQ/RSQ.

Model	X^2	df	X^2/df	CFI	RMSEA
Single-factor model	41,452.15	665	62.33	0.90	0.18
Two-factor model	15,913.56	664	23.97	0.96	0.11
Bi-factor model	3726.82	627	5.94	0.99	0.05

N = 2256. X^2 = chi-square goodness of fit statistic; df = degrees of freedom; CFI = comparative fit index; RMSEA = root mean square error of approximation.

Table 3
Goodness of fit statistics for alternative models of the PSWQ/RRQ (24 items).

Model	X^2	df	X^2/df	CFI	RMSEA
Single factor	43,822.59	740	59.22	0.87	0.19
Content-specific	8402.85	737	11.40	0.98	0.08
Valence	17,397.17	739	23.54	0.95	0.12
Content-specific bifactor	4937.13	700	7.05	0.99	0.05
Valence bifactor	7239.72	711	10.18	0.98	0.08

Note. N = 2428. X^2 = chi-square goodness of fit statistic; df = degrees of freedom; CFI = comparative fit index; RMSEA = root mean square error of approximation.

Table 4
Factor loadings for the content-specific bifactor model.

PSWQ/RRQ Items	Repetitive Thinking	Worry Specific	Rumination Specific	Reflection Specific
PSWQ				
If I don't have enough time to do everything, I don't worry about it.	0.29	0.41		
My worries overwhelm me.	0.64	0.51		
I don't intend to worry about things.	0.47	0.48		
Many situations make me worry.	0.63	0.55		
I know I shouldn't worry about things, but I just can't help it.	0.62	0.58		
When I am under pressure, I worry a lot.	0.56	0.52		
I am always worrying about something.	0.64	0.59		
I find it easy to dismiss worrisome thoughts.	0.56	0.42		
As soon as I finish one task, I start to worry about everything else I have to do.	0.48	0.53		
I never worry about anything.	0.56	0.54		
When there is nothing I can do about a concern, I don't worry about it anymore.	0.43	0.31		
I've been a worrier all of my life.	0.54	0.55		
I notice that I have been worrying about things.	0.61	0.57		
Once I start worrying, I can't stop.	0.66	0.49		
I worry all the time.	0.65	0.61		
I worry about projects until they are done.	0.50	0.50		
RRQ-Rumination items				
My attention is often focused on aspects of myself I wish I'd stop thinking about.	0.68		0.15	
I always seem to be "re-hashing" in my mind recent things I've said or done.	0.64		0.48	
Sometimes it is hard for me to shut off thoughts about myself.	0.71		0.28	
Long after an argument or disagreement is over with, my thoughts keep going back to what happened.	0.67		0.41	
I tend to "ruminate" or dwell over things that happen to me for a really long time afterward.	0.76		0.37	
I don't waste time re-thinking things that are over and done with.	0.67		0.23	
Often I'm playing back over in my mind how I acted in a past situation.	0.62		0.68	
I often find myself re-evaluating something I've done.	0.60		0.59	
I never ruminate or dwell on myself for very long.	0.60		0.17	
It is easy for me to put unwanted thoughts out of my mind.	0.78		−0.08	
I often reflect on episodes in my life that I should no longer concern myself with.	0.61		0.38	
I spend a great deal of time thinking back over my embarrassing or disappointing moments.	0.61		0.40	
RRQ-Reflection items				
Philosophical or abstract thinking doesn't appeal to me that much.	−0.13			0.59
I'm not really a meditative type of person.	−0.14			0.50
I love exploring my "inner" self.	0.14			0.64
My attitudes and feelings about things fascinate me.	−0.11			0.53
I don't really care for introspective or self-reflective thinking.	0.12			0.75
I love analyzing why I do things.	0.24			0.69
People often say I'm a "deep," introspective type of person.	−0.03			0.53
I don't care much for self-analysis.	0.16			0.77
I'm very self-inquisitive by nature.	0.23			0.63
I love to meditate on the nature and meaning of things.	0.16			0.71
I often love to look at my life in philosophical ways.	0.06			0.72
Contemplating myself isn't my idea of fun.	−0.01			0.43

Note. N = 2428.

factor was strongly positively associated with openness and moderately positively correlated with attention to emotion.

5. Discussion

The current study replicated the finding that a bifactor model provides the best fit for worry and rumination variance (Hur et al., 2017; Madian et al., 2019). This bifactor structure contains a general factor that captures the common variance in worry and rumination, and specific worry and rumination factors. Importantly, we replicated these findings with a much larger sample and with an alternative measure of rumination, the RSQ. Furthermore, we expanded previous findings by examining another type of repetitive thinking, reflection. We found that a bifactor model provided the best fit for worry, rumination, and

Table 5
Structural relations between the PSWQ/RRQ factors and relevant correlates.

Phenomena	N	Repetitive thinking	Worry	Rumination	Reflection
Distress					
Anhedonic depression	270	0.43*	0.06	0.04	−0.09
Anxious arousal	270	0.12	0.12	0.10	0.10
Personality					
Neuroticism	270	0.52*	0.45*	−0.01	0.03
Extraversion	270	−0.15	−0.10	−0.12	−0.04
Openness	270	−0.03	−0.23*	0.09	0.55*
Agreeableness	270	0.09	0.10	−0.06	0.13
Conscientiousness	270	0.01	0.32*	0.10	0.01
Distress correlates					
Attention to emotion					
DERS	142	0.05	−0.03	−0.02	0.48*
TMMS	270	0.07	0.13	0.04	0.24*
Clarity of emotion					
DERS	142	−0.35*	0.08	−0.02	0.16
TMMS	270	−0.33*	0.20	0.03	0.17
Impulsivity		0.31*	−0.08	−0.12	0.09
Limited goal behavior	142	0.33*	0.19	0.13	0.08
Limited strategies	142	0.39*	0.12	0.19	0.04
Intolerance of uncertainty	142	0.33*	0.43*	0.18	0.00
Emotion nonacceptance	142	0.28*	0.04	0.50*	0.05

Note. Presented numbers are standardized coefficients (ranging from −1 to 1). Asterisks (*) indicate coefficients that were significant at $p < .01$. All rows with N = 270 are based on two separate samples; rows with N = 142 are based on one of those two samples.

reflection. By examining a much broader range of correlates than had been explored in previous research, we are able to better understand what these factors appear to be measuring.

Most of the items that loaded heavily on the general repetitive thinking factor represented a lack of control over thoughts and time spent with unpleasant intrusive thoughts. For example, the worry items, "Once I start worrying, I can't stop" and "I worry all the time," were the highest loading items on the general repetitive thinking factor. Similarly, the rumination items, "I tend to ruminate or dwell over things that happen to me for a really long time afterward" and the reverse-coded rumination item, "It is easy for me to put unwanted thoughts out of my mind," were the highest loading items on the general repetitive thinking factor. None of the reflection items had high loadings on the general repetitive thinking factor (the highest loading was 0.24). Thus, it appears that the general repetitive thinking factor is primarily tapping a lack of control over unwanted thoughts associated with repetitive thinking.

Previous research has found that deficits in cognitive control are strongly associated with internalizing psychopathology (Snyder & Hankin, 2016). For example, Joormann and Gotlib (2008) found that people with major depressive disorder had more difficulty removing irrelevant negative information from working memory than did control participants. Along the same lines, Berenbaum et al. (2018) found that individuals for whom there was more pronounced intrusive interference of unpleasant emotional content on performance on a rapid serial visual presentation (RSVP) task tended to have more difficulty terminating their worries. That the general repetitive thinking factor may be associated with deficits in cognitive control and vulnerability to internalizing psychopathology is consistent with previous research showing that the general repetitive thinking factor was associated not only with anhedonic depression, but also with neuroticism and poor emotion regulation, both of which are associated with internalizing psychopathology (Shapero et al., 2016; Zinbarg et al., 2016).

Almost all of the worry items had high loadings on the worry-specific factor. The items with the highest loadings were "I worry all the time" and "I am always worrying about something." The items whose loadings on the worry-specific factor were smallest relative to their loadings on the general repetitive thinking factor were "Once I start worrying I can't stop" and "I find it easy to dismiss worrisome thoughts." Thus, relative to the general repetitive thinking factor, the worry-specific factor emphasizes time spent on worry rather than a lack of control over worry. Unlike the general repetitive thinking factor, the worry-specific factor was not associated with anhedonic depression. The worry-specific factor was associated with increased neuroticism, increased intolerance of uncertainty, and diminished openness. This pattern suggests that the worry-specific factor is associated with neuroticism but not psychological distress, and taps closed mindedness and inflexibility. The worry-specific factor was also positively associated with conscientiousness. Although past research has found that Generalized Anxiety Disorder (GAD), which is characterized by excessive worry, is associated with diminished levels of conscientiousness (Kotov et al., 2010; Watson & Naragon-Gainey, 2014), there is evidence that non-pathological measures of worries are associated with slightly increased levels of conscientiousness (Furnham et al., 2012; Rammstedt, 2007). It is also worth noting that perfectionism, which is positively associated with worry (e.g., Stöber & Joormann, 2001), is also positively associated with conscientiousness (e.g., Stoeber et al., 2009). Thus, this pattern of findings suggests that whereas the general repetitive thinking factor captures the variance responsible for the dysfunctional aspects of worry, the worry-specific factor captures the variance associated with inflexible, future-oriented thoughts related to high standards.

The items that loaded heavily on the rumination-specific factor concerned thoughts about past events. For example, the rumination items, "Often I'm playing back over in my mind how I acted in a past situation," and "I often find myself re-evaluating something I've done," were the highest loading items on the rumination-specific factor. Furthermore, the rumination-specific factor was positively associated with emotion nonacceptance. Thus, it appears that this factor is tapping the tendency to think about past events and lack of acceptance about those past events. Our finding is consistent with the literature on worry and rumination as it has been extensively documented that worry concerns possible negative outcomes in the future, whereas rumination concerns past events (Nolen-Hoeksema et al. 2008). Ruminative thoughts often explore what happened in an unpleasant event, why it happened, and the losses and personal failures associated with those events. Given that rumination focuses on past losses and failures, it follows that the rumination-specific factor was positively associated with nonacceptance of emotional responses. It seems that what is unique to rumination (i.e., that which is leftover after removing shared variance with other forms of repetitive thinking) is that it has a past temporal orientation and captures an inability to accept the emotional responses associated with past negative events.

Reflection items that loaded heavily on the reflection-specific factor were somewhat different than the type of reflection items that loaded heavily on the other factors. High loading reflection items on the reflection-specific factor were related to intellectual introspection. For example, the reverse-coded reflection items, "I don't care much for self-analysis," and "I don't really care for introspective or self-reflective thinking," were the highest loading items on the reflection-specific factor. Furthermore, the reflection-specific factor was positively correlated with openness, which is defined as an enduring tendency to engage in self-examination (Vartanian et al., 2018). This factor was also positively associated with attention to emotion. Thus, it appears that the reflection-specific factor is primarily tapping a tendency to contemplative self-analysis.

Our research has a number of limitations and suggests avenues for future research. First, like previous studies, the data in our study were cross-sectional. It would be valuable to measure repetitive thinking patterns with a longitudinal design to gain a better understanding of the causal relations between repetitive thinking and its associations (e.g., anhedonic depression, emotion nonacceptance, intolerance of

uncertainty, reflection and openness). Such a design would also provide information about the stability of the repetitive thinking factors over time. Second, our interpretations are limited by the instruments that we used. Although a strength of our research is that we replicated our findings using two alternative measures of rumination, we had only single measures of worry and reflection. It is possible that other instruments may capture variance that is specific to worry and reflection that may not have been captured by the PSWQ and RRQ. In particular, it would be valuable to examine instruments that measure non-pathological worry (in contrast to the PSWQ, which is typically considered a measure of pathological worry). Similarly, it would be valuable to replicate our research with an alternative measure of pleasant repetitive thinking such as the Responses to Positive Affect (Feldman et al., 2008). None of the reflection items had high loadings on the general repetitive thinking factor. It is worth noting that none of the RRQ reflection items measure a lack of control over reflective thoughts. Without an instrument that measures a lack of control over pleasant repetitive thinking,[4] it will remain unknown whether a broad perseverative iterative style that is not valence-specific (whose existence is suggested by Study 4 in Davey & Levy, 1998) and that reflects a lack of cognitive control is specific to negative repetitive thinking or is common to all repetitive thinking.

It will be valuable for future research to examine associations between the factors of the content-specific bifactor model and a much broader range of psychopathology. There are many forms of psychopathology that may be relevant to repetitive thinking. For example, obsessions, or repetitive unwanted ideas and images, are a cardinal feature of obsessive-compulsive disorder (Blom et al., 2011). Similarly, people with substance use disorders have difficulty expelling from their minds thoughts about their preferred substance (Addolorato et al., 2005), people with bipolar disorder ruminate about pleasant events more than do control participants (Gruber et al., 2011), and people with PTSD report having intrusive thoughts associated with trauma (Falsetti et al., 2002). Thus, our understanding of numerous forms of psychopathology has the potential to benefit from exploring how they are similarly and differently associated with the different aspects of repetitive thinking. Ultimately, this type of research has the potential to inform the target(s) of treatment. For example, rather than targeting worry and/or rumination, it may be more effective to target non-specific repetitive thinking and/or that aspect of repetitive thinking unique to worry and/or that aspect unique to rumination.

CRediT authorship contribution statement

Ariana A. Castro: Conceptualization, Methodology, Software, Writing – original draft, Writing – review & editing, Data curation. **Juyoen Hur:** Software, Formal analysis, Writing – review & editing. **Howard Berenbaum:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Resources, Supervision.

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[4] An example of how such an item might be worded is "When I start thinking about what I want to achieve in life, I cannot stop."

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