ORIGINAL RESEARCH REPORT

Evidence for Transdiagnostic Repetitive Negative Thinking and Its Association with Rumination, Worry, and Depression and Anxiety Symptoms: A Commonality Analysis

Daniel E. Gustavson[*], Alta du Pont[†], Mark A. Whisman[‡] and Akira Miyake[‡]

Recent theoretical advances have emphasized the commonality between rumination and worry, often referred to as repetitive negative thinking. Although not studied extensively, repetitive negative thinking may not only account for a substantial overlap between depression and anxiety symptoms but also encapsulate other constructs including one's tendency to experience unwanted intrusive thoughts or have low levels of mindfulness. In this study, 643 college students completed self-report questionnaire measures of repetitive negative thinking (the Habit Index of Negative Thinking) and other relevant constructs including rumination, worry, depression and anxiety symptoms, intrusive thoughts, and mindfulness. To analyze the data, we conducted systematic commonality analyses, which algebraically decomposed shared variances among these measures into various unique components. Results in Study 1 indicated that individual differences in repetitive negative thinking were explained largely by the overlap between rumination and worry, but also by some rumination-specific and worry-specific variance. Moreover, the shared variation in rumination and worry explained the frequencies of depression and anxiety symptoms and their overlap. We also found in Study 2 that repetitive negative thinking was positively related to intrusive thoughts and negatively related to mindfulness. These associations were mostly explained by shared variance with rumination and worry, but there was also some mindfulness-specific variance. These results suggest that repetitive negative thinking may indeed lie at the core of the comorbidity between depression and anxiety symptoms, but that it is also a broader construct that encompasses intrusive thoughts and low levels of mindfulness.

Rumination, defined as past-oriented mental perseveration on causes and consequences of one's distress, is associated with increased risk of developing depression and duration of depressive episodes (Nolen-Hoeksema, 2000; Nolen-Hoeksema, Morrow, & Fredrickson, 1993; Roberts, Gilboa, & Gotlib, 1998). Similarly, worry, defined as future-oriented repetitive thinking about potential threats, uncertainties, and risks, is a primary symptom of generalized anxiety disorder (Borkovec, Ray, & Stober, 1998; Hoyer, Becker, &

* Department of Psychiatry and Center for Behavior Genetics of Aging, University of California, San Diego, La Jolla, CA, US

† Institute for Behavioral Genetics and Department of Psychology and Neuroscience, University of Colorado Boulder, Boulder, CO, US

‡ Department of Psychology and Neuroscience, University of Colorado Boulder, Boulder, CO, US

Corresponding author: Daniel E. Gustavson (dgustavson@ucsd.edu)

Margraf, 2002), and has negative health consequences, even at subclinical levels (Haller, Cramer, Lauche, Gass, & Dobos, 2014).

Although rumination and worry have often been studied separately, researchers have noted the substantial shared variance between them (Fresco, Frankel, Mennin, Turk, & Heimberg, 2002; McEvoy & Brans, 2013; Spinhoven, Drost, van Hemert, & Penninx, 2015; Topper, Molenaar, Emmelkamp, & Ehring, 2014). Moreover, they have begun to examine *repetitive negative thinking*—defined as "repetitive thinking about one or more negative topics that is experienced as difficult to control" (Ehring & Watkins, 2008, p. 193)—as a general cognitive tendency that encompasses not only rumination and worry, but also perseverative cognition, counterfactual thinking, and other similar processes (Watkins, 2008). By examining repetitive negative thinking, researchers aim to shed light on common features of psychopathology and the high comorbidity between depression and anxiety (Ehring &

Watkins, 2008; Fresco et al., 2002; Rood, Roelofs, Bogels, & Alloy, 2010; Spinhoven et al., 2015; Watkins, 2008).

Significant strides have been made toward assessing repetitive negative thinking through the development of self-report measures, including the Habit Index of Negative Thinking (HINT; Verplanken, Friborg, Wang, Trafimow, & Woolf, 2007), the Perseverative Thinking Questionnaire (PTQ; Ehring et al., 2011), and the Repetitive Thinking Questionnaire (RTQ; Mahoney, McEvoy, & Moulds, 2012). These measures differ from measures of rumination and worry in that they do not target specific past- or future-oriented or mood-specific negative thinking. Thus, those measures are intended to capture general tendencies for repetitive negative thinking without directly assessing rumination or worry.

The present research builds on this growing body of research and seeks to better understand the nature of repetitive negative thinking, as measured by the HINT, using a data-analytic method known as commonality (or element) analysis (Newton & Spurrell, 1967; Nimon, Lewis, Kane, & Haynes, 2008). Specifically, we tested three hypotheses regarding the nature of repetitive negative thinking and its associations with several related constructs. In Study 1, we examined the overlap between repetitive negative thinking, rumination, worry, and depression and anxiety symptoms in a large unselected sample of 643 undergraduate students. In Study 2, we examined, in subsets of the full dataset ($N = 227$ and 233, respectively), the relations to two constructs—intrusive thoughts and (low levels of) mindfulness—that we hypothesized should overlap considerably with negative repetitive thinking. Together, the results of these commonality analyses provide new insights into the nature of the associations between repetitive negative thinking and these related constructs in a way that complements typical regression-based analyses.

Study 1: Associations Between Repetitive Negative Thinking, Rumination, Worry, and Depression and Anxiety Symptoms

The Transdiagnostic Nature of Repetitive Negative Thinking for Depression and Anxiety

Previous research using measures of repetitive negative thinking has highlighted its relevance to multiple forms of psychopathology, including depression and anxiety (Ciesla, Dickson, Anderson, & Neal, 2011; Fresco et al., 2002; Mahoney et al., 2012; Raes, 2012). In a sample of 2,143 individuals from the Netherlands, for example, Spinhoven et al. (2015) found that 84% of the shared variance between rumination and worry overlapped with repetitive negative thinking measured by the PTQ. Furthermore, a latent variable comprised of rumination, worry, and PTQ scores strongly predicted the comorbidity between depressive and anxiety disorders, with a small unique path from rumination to depressive disorder observed beyond the latent variable (Spinhoven et al., 2015). These results suggest that most of the variance in depressive and anxiety disorders explained by rumination and worry reflects repetitive negative thinking, and that the explanatory power of rumination-specific or worry-specific negative thinking may be rather limited.

These findings are also consistent with other factor analytic work on repetitive negative thinking. Compared to a two-factor solution (i.e., separable factors for worry and rumination), bifactor models involving a common repetitive negative thinking factor with rumination-specific and worry-specific factors provided a better fit to the data in a sample of adolescents and university students (Topper et al., 2014) and also in a sample of adults with anxiety and affective disorders (McEvoy & Brans, 2013). In these studies, repetitive negative thinking was more strongly correlated with depression and anxiety symptoms than the rumination-specific or worry-specific factors (McEvoy & Brans, 2013), and repetitive negative thinking fully accounted for changes in later depression and anxiety symptoms in university students up to six months later (Topper et al., 2014). These findings suggest that repetitive negative thinking may explain some of the previously observed associations between rumination/worry and later depression and anxiety symptoms (Calmes & Roberts, 2007; Hong, 2007).

Important to note, these previous studies examined the association between repetitive negative thinking, rumination-specific variance, and worry-specific variance with latent variables for depression and anxiety symptoms. However, they have not examined whether the covariance between depression and anxiety symptoms may be part of this same overlapping variance in repetitive negative thinking. Similarly, it remains unclear how much of the overlap between depression and anxiety can be explained by repetitive negative thinking. Therefore, the primary goal of Study 1 was to address this limitation in the prior literature by testing, in an unselective sample of undergraduate students, two specific hypotheses regarding the nature of the associations between repetitive negative thinking (as measured by the HINT) and the overlap between rumination, worry, and depression and anxiety symptoms.

Data-Analytic Approach and the Hypotheses of Study 1
In Studies 1 and 2, we analyzed the data using a data-analytic technique known as commonality analysis (Newton & Spurrell, 1967; Nimon et al., 2008). Although this approach has been used in the analysis of individual differences in cognitive abilities in adults and children (Cowan et al., 2005; Unsworth, Spillers, & Brewer, 2011), its application to clinical psychology has been limited (e.g., Kahn, Hessling, & Russell, 2003). For this reason, we first describe the commonality analysis approach, followed by the specific hypotheses and predictions of Study 1.

Data-analytic approach
Commonality analysis involves fitting regression models that systematically vary in the predictor variables included, and then uses the R^2 values of each model to algebraically decompose the variance explained by multiple predictors into unique variance components. Although the commonality-analysis approach is based on multiple regression, its main purpose and focus are quite different. Multiple regression analyses are typically used to quantify the unique variance in the outcome variable that a particular predictor variable can account for above and

beyond all other covariates included in the model. Thus, the emphasis is on the *unique* contribution of a predictor variable of interest in explaining the total variance in the outcome variable.

One important limitation of multiple regression analyses, however, is that it does not explicitly consider the contribution of the variance shared across multiple predictors in explaining the total variance. For example, although a multiple regression analysis may reveal that individual differences in ruminative tendencies can significantly explain participants' depression symptoms after controlling for those in worry (e.g., accounting for an additional 5% of the total variance), it does not shed direct light on the fact that rumination and worry are correlated substantially and, hence, that the commonality of these predictors may actually account for a much larger portion of the total variance in depression symptoms.

Commonality analysis is designed to quantify how much variance is explained by the *commonality* of the relevant predictor variables by systematically comparing the R^2 values of multiple models (e.g., the model including both predictors simultaneously, the model including rumination only, the model including worry only) and algebraically breaking down the total variance in the target outcome variable into various unique and shared sources. In this regard, commonality analysis is complementary to standard multiple regression analyses.

As is true of multiple regression analyses, one limitation to this approach is that there is no direct statistical test for significance of those variance components identified as common to multiple predictors. In the current study, we tried to alleviate this limitation by estimating a bootstrapped 95% confidence interval (CI) for each variance component using resampling procedures (Chernick, González-Manteiga, Crujeiras, & Barrios, 2011; Efron & Tibshirani, 1986). Thus, we can more directly compare the variance captured by multiple predictors across their shared and unique sources of variance.

Study 1 Hypotheses

Study 1 examined two hypotheses, which are schematically illustrated in **Figure 1**. The first hypothesis was that repetitive negative thinking, as measured by the HINT, should capture common variance between rumination and worry (Hypothesis 1). Each circle of the Venn diagram in **Figure 1A** represents the proportion of variance in *repetitive negative thinking* accounted for by that construct (R^2), and small letters denote unique variance components. For example, variance in repetitive negative thinking explained by rumination is captured by the sum of the variance unique to rumination (*a*) and the variance shared between rumination and worry (*b*). If repetitive negative thinking primarily captures the overlap between rumination and worry, then a substantial portion of the shared variance with repetitive negative thinking should appear in the shaded overlapping portion of the figure (*b*), rather than by variance unique to rumination (*a*) or worry (*c*), even though there likely exists such rumination- and worry-specific variance. Throughout the study, we considered portions of variance as "substantial" if the estimates for that variance component were larger than those it was

compared against (e.g., section *b* vs. *a* or *c* in **Figure 1A**), and if the 95% CI did not include zero.

The second hypothesis consisted of two complementary subhypotheses. First, we tested the hypothesis that the variance identified as repetitive negative thinking in the first step should also overlap substantially with symptoms of depression and anxiety (Hypothesis 2A). The shaded portion in **Figure 1B** again represents the variation in negative repetitive thinking that overlaps with both rumination and worry (section *b* from **Figure 1A**), but it is further decomposed into four subsections (*d, e, f,* and *g*). If most of the overlap between rumination and worry that is attributable to repetitive negative thinking also underlies both depression and anxiety symptoms, then a substantial portion of the variation in repetitive negative thinking should be captured by the four-way overlap between all constructs (cross-shaded section *g*). In contrast, there should be limited overlap between rumination and worry that is not also shared between depression and anxiety symptoms (*d*). Finally, repetitive negative thinking should not be substantially associated with variance unique to depression symptoms as well as to anxiety symptoms (i.e., *h* and *i*, respectively, should be estimated at or near 0), because the associations between these constructs and repetitive negative thinking should be captured by their respective associations with rumination and worry.

We also tested the complementary hypothesis that repetitive negative thinking should account for most of the overlap between symptoms of depression and anxiety (Hypothesis 2B). As illustrated in **Figure 1C**, the dependent measure here is the measure of depression or anxiety symptoms, and repetitive negative thinking is used as one of the predictors. Consider the regression analyses in which depression symptoms serve as the dependent measure. In this case, the shaded circle represents the variation in depression symptoms accounted for by anxiety symptoms. We predicted that a substantial portion of the overlap between depression and anxiety symptoms should be captured by the four-way overlap between rumination, worry, anxiety symptoms, and repetitive negative thinking (cross-shaded section *j*). We also predicted that a smaller portion of the overlap between depression and anxiety symptoms should be attributable to the variance specific to anxiety symptoms that does not overlap with any of the other constructs (*k*). Similar results should be obtained for the regression analyses predicting anxiety symptoms.

Method
Participants
A total of 643 undergraduate students participated in the study (374 women, 268 men, 1 chose not to specify gender; M = 19.19 years old, SD = 1.63).[1] These participants took part in one of five studies conducted separately at the University of Colorado Boulder between 2010 and 2015, whose primary goal was to examine the hypotheses put forth by Attentional Control Theory regarding the relationship between trait anxiety and executive function abilities (Eysenck, Derakshan, Santos, & Calvo, 2007).

All five studies were approved by the Institutional Review Board at the University of Colorado Boulder. In all studies, participants were recruited through the online
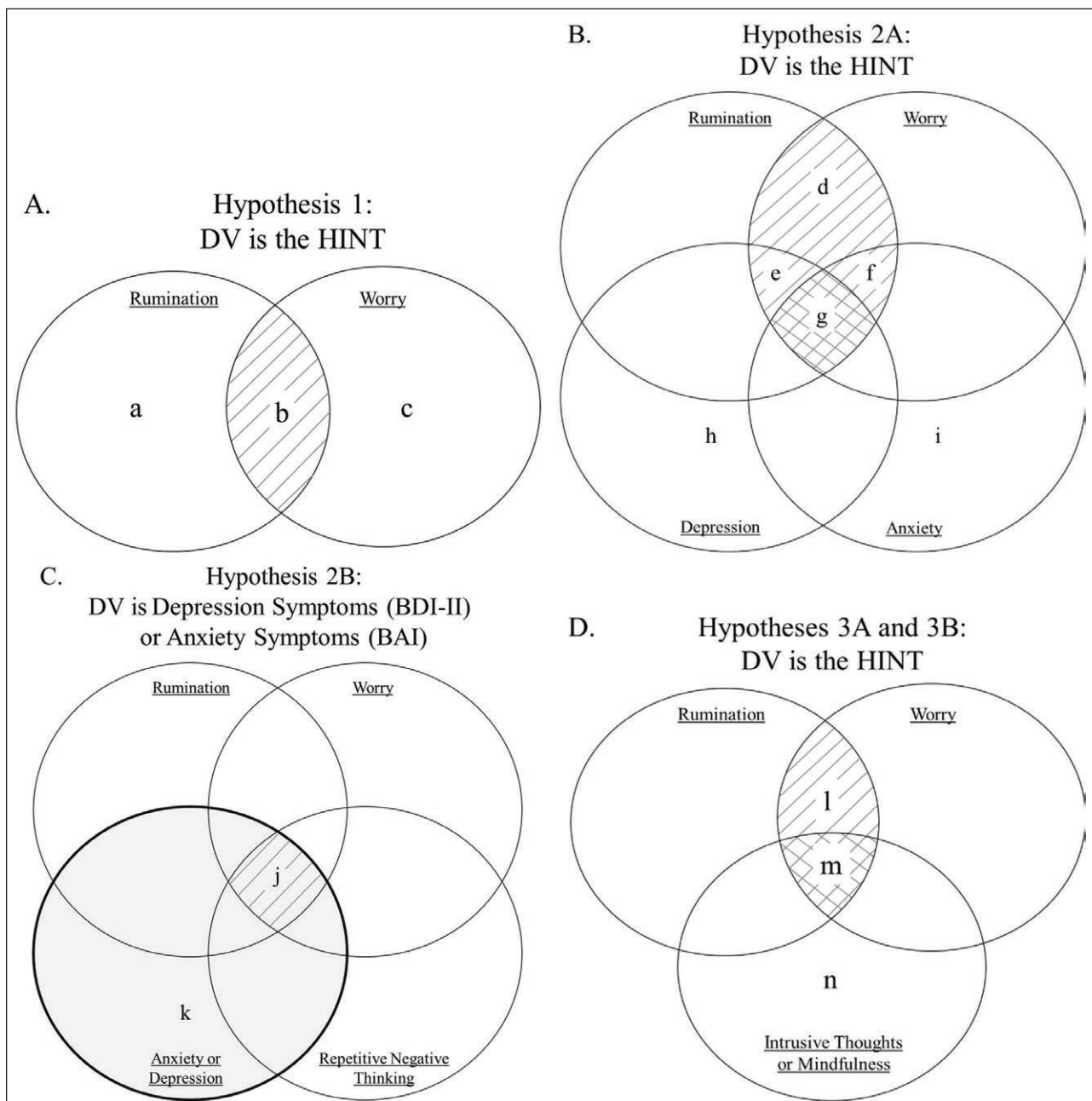
Figure 1: Examples of commonality analyses used to describe the hypotheses of the study. Each section of the Venn diagram displays the variation in the dependent measure (the Habit Index of Negative Thinking for Figures A, B, and D, and the Beck Depression Inventory-II or Beck Anxiety Inventory for Figure C) explained by those constructs. Letters inside each figure refer to key variance components that are identified in these analyses. Shaded sections in **A**, **B**, and **D** represent variation in repetitive negative thinking explained by the overlap between rumination and worry, and the shaded section in **C** is the variation in depression or anxiety symptoms explained by the other construct. DV = Dependent variable; HINT = Habit Index of Negative Thinking; BDI-II = Beck Depression Inventory-II; BAI = Beck Anxiety Inventory.

undergraduate participant pool composed of students attending an introductory to psychology course and were compensated for partial course credit (3 credits out of the 12 needed for assignment completion).

Although the five studies included different measures, each was similarly structured and was completed in a 90-min session in a laboratory. In all studies, participants first completed 1–3 cognitive measures of executive function (about 20–40 min per task), followed by the questionnaire measures of repetitive negative thinking and related dispositional (rather than state) mood

variables used in the current study.[2] All cognitive tasks involved emotionally neutral and nonthreatening stimuli,[3] and none of the five studies included manipulations for inducing positive/negative moods or state anxiety.

The correlations between the HINT and the other questionnaire measures were generally consistent across samples (see Table S1 in Appendix A). Thus, for simplicity, our analyses collapsed all five samples into a single sample. Although the general consistency of the patterns of the correlations with the HINT shown in Table S1 justifies collapsing the five samples, the pattern of results remained

the same even when we used hierarchical linear modeling (clustering by sample).

Measures

Repetitive negative thinking was measured with the HINT (Verplanken et al., 2007), which was designed to assess the degree to which negative self-thoughts "occur often, are unintended, are initiated without awareness, are difficult to control, and are self-descriptive" (p. 526). Twelve items were rated on a 1–5 scale in response to the general prompt, "Thinking negatively about myself is something. . ." Example items include: "I do unintentionally," "I start doing before I realize I'm doing it," and "I do every day." The HINT has been shown to be internally consistent (α = .94; Verplanken et al., 2007).

Depressive rumination was assessed with the combined brooding and reflection on sadness subscales (5 items each) of the Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991). Worry was assessed with the 16-item Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990). Depression symptoms were assessed using the 21-item Beck Depression Inventory-Second Edition (Beck, Steer, & Brown, 1996). Anxiety symptoms were assessed using the 21-item Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988).

Data Analysis

As explained earlier, commonality analyses are based on a series of systematic multiple regression analyses. Thus, where possible, we report whether the unique variance captured in a relevant specific section in a Venn diagram is significantly different from zero. As also noted, however, one limitation of this approach is that there is no direct way to statistically test whether an overlapping component in a Venn diagram accounts for a significant amount of variance. To alleviate this limitation, we report bootstrapped 95% CIs for variance components that cannot be directly tested using regression. These CIs were derived by sampling a random subset of 300 individuals from the full sample (~46.7% of the sample) across 1,000 iterations (Chernick et al., 2011; Efron & Tibshirani, 1986). Because those 95% CI estimates are based on random resampling, the lowest bound of the CIs is 0, rather than negative numbers.

Results

Descriptive statistics and reliability estimates for all the questionnaire measures administered in Study 1 (as well as in Study 2) are presented in **Table 1**, and Pearson correlations between them are presented in **Table 2**. As expected, all constructs in Study 1 were significantly and

Table 1: Descriptive Statistics of the Measures Used in Studies 1 and 2.

Measure	n	Mean	SD	Skewness	Kurtosis	Cronbach's Alpha
HINT	643	32.82	10.16	–0.03	–0.46	0.93
RRS	643	18.80	5.78	0.65	–0.14	0.85
PSWQ	643	47.83	13.65	0.07	–0.64	0.72
BDI-II	643	11.36	9.64	1.53	3.23	0.91
BAI	643	11.45	9.40	1.36	1.95	0.92
WBSI	227	42.60	10.75	–0.43	0.02	0.90
FFMQ	233	127.06	15.01	0.05	0.48	0.78

Note. The BDI-II and BAI were only used in Study 1, and the WBSI and FFMQ were only used in Study 2. HINT = Habit Index of Negative Thinking; RRS = Ruminative Responses Scale; PSWQ = Penn State Worry Questionnaire; BDI-II = Beck Depression Inventory-II; BAI = Beck Anxiety Inventory; WBSI = White Bear Suppression Inventory; FFMQ = Five Facet Mindfulness Questionnaire.

Table 2: Correlations Between All Measures in Studies 1 and 2.

	HINT	RRS	PSWQ	BDI-II	BAI	WBSI	FFMQ
HINT	–						
RRS	0.48	–					
PSWQ	0.51	0.49	–				
BDI-II	0.51	0.56	0.51	–			
BAI	0.41	0.51	0.51	0.59	–		
WBSI[a]	0.34	0.45	0.31	0.43	0.36	–	
FFMQ[b]	–0.45	–0.23	–0.46	–0.41	–0.28	N/A	–

Note. [a] N = 227; [b] N = 233. The BDI-II and BAI were only used in Study 1, and the WBSI and FFMQ were only used in Study 2. All correlations are statistically significant (p < .001). HINT = Habit Index of Negative Thinking; RRS = Ruminative Responses Scale; PSWQ = Penn State Worry Questionnaire; BDI-II = Beck Depression Inventory-II; BAI = Beck Anxiety Inventory; WBSI = White Bear Suppression Inventory; FFMQ = Five Facet Mindfulness Questionnaire.
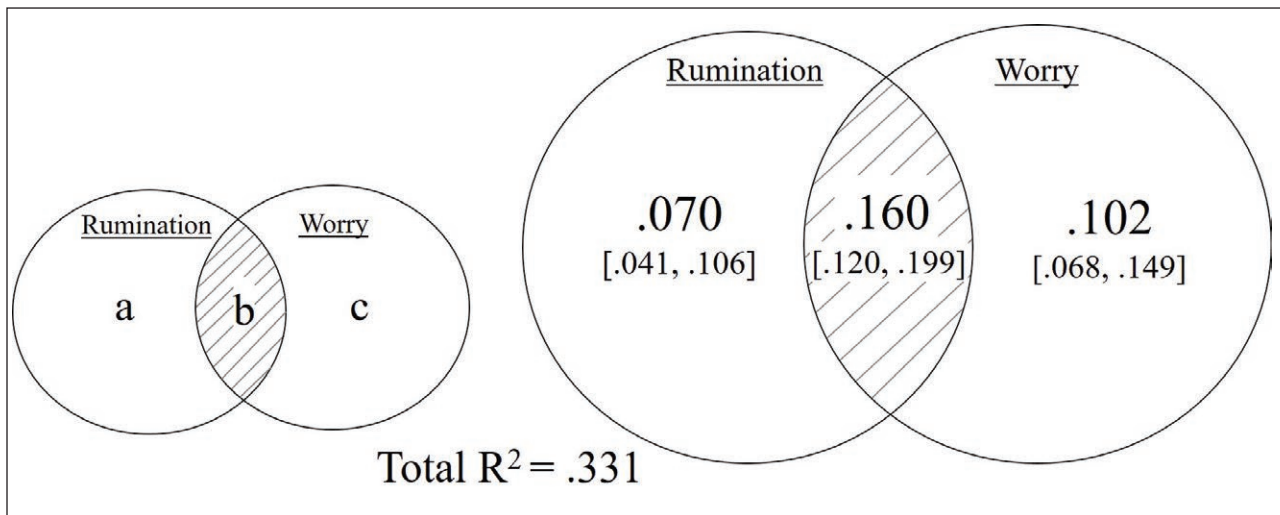
Figure 2: Commonality analyses for Hypothesis 1 involving rumination and worry. Values inside each section of the diagram display the percent variation in repetitive negative thinking (measured by the HINT) that can be explained by the overlap between rumination (center), or unique variance to rumination (RRS, left) or worry (PSWQ, right). The predictions displayed in Figure 1A are recreated on the bottom left for reference.

positively correlated with one another. These moderate correlations justified our use of commonality analyses to decompose these associations into their shared and unique variance components.

Although most participants in this sample experienced low levels of depression and/or anxiety, a substantial portion of the sample experienced moderate or severe symptoms. Specifically, 62 participants reached the threshold for moderate depression on the BDI-II (score 20–28), and 38 individuals could be classified as experiencing severe depression (score 29–63). Additionally, 159 individuals reached the threshold for moderate anxiety on the BAI (score >15), and 54 of these individuals could be classified as experiencing severe anxiety (score >25).

Overlap with rumination and worry (Hypothesis 1)

Results of the commonality analysis examining repetitive negative thinking, rumination, and worry are summarized in **Figure 2**, which were derived from the R^2 values from the regression models summarized in **Table 3**.[4]

As shown in the center of **Figure 2** (right panel), 16.0% of the variation in repetitive negative thinking was explained by the overlap between rumination and worry (section *b*, CI [12.0%, 19.9%]). Variance unique to rumination (*a*) explained an additional 7.0% of the variation in repetitive negative thinking, CI [4.1%, 10.6%], and variance unique to worry (*c*) explained an additional 10.2% of the variation, CI [6.8%, 14.9%]. Therefore, consistent with our hypothesis that repetitive negative thinking would be primarily accounted for by the overlap between rumination and worry, about half (16.0%) of the total variance in repetitive negative thinking that was explained by rumination and worry (33.1%) was accounted for by shared variance between rumination and worry, rather than unique variance to each. However, because the unique effects of rumination (7.0%) and worry (10.2%) were statistically significant (both *p*s < .001), the HINT

Table 3: R^2 Values for the Individual Models Used for Commonality Analysis for Hypotheses 1 and 2A in Study 1.

Predictors in Model	Model R^2
Hypothesis 1 (Figure 2)	
RRS + PSWQ	0.331
RRS	0.229
PSWQ	0.261
Hypothesis 2A (Figure 3)	
RRS + PSWQ + BDI-II + BAI	0.370
RRS + PSWQ + BDI-II	0.370
RRS + PSWQ + BAI	0.338
RRS + BDI-II + BAI	0.320
PSWQ + BDI-II + BAI	0.347
RRS + PSWQ	0.331
RRS + BDI-II	0.315
RRS + BAI	0.265
PSWQ + BDI-II	0.345
PSWQ + BAI	0.289
BDI-II + BAI	0.278
RRS	0.229
PSWQ	0.261
BDI-II	0.261
BAI	0.165

Note. In all regressions, the dependent measure was the Habit Index of Negative Thinking. All model R^2 were significant (*p* < .001). RRS = Ruminative Responses Scale; PSWQ = Penn State Worry Questionnaire; BDI-II = Beck Depression Inventory-II; BAI = Beck Anxiety Inventory.
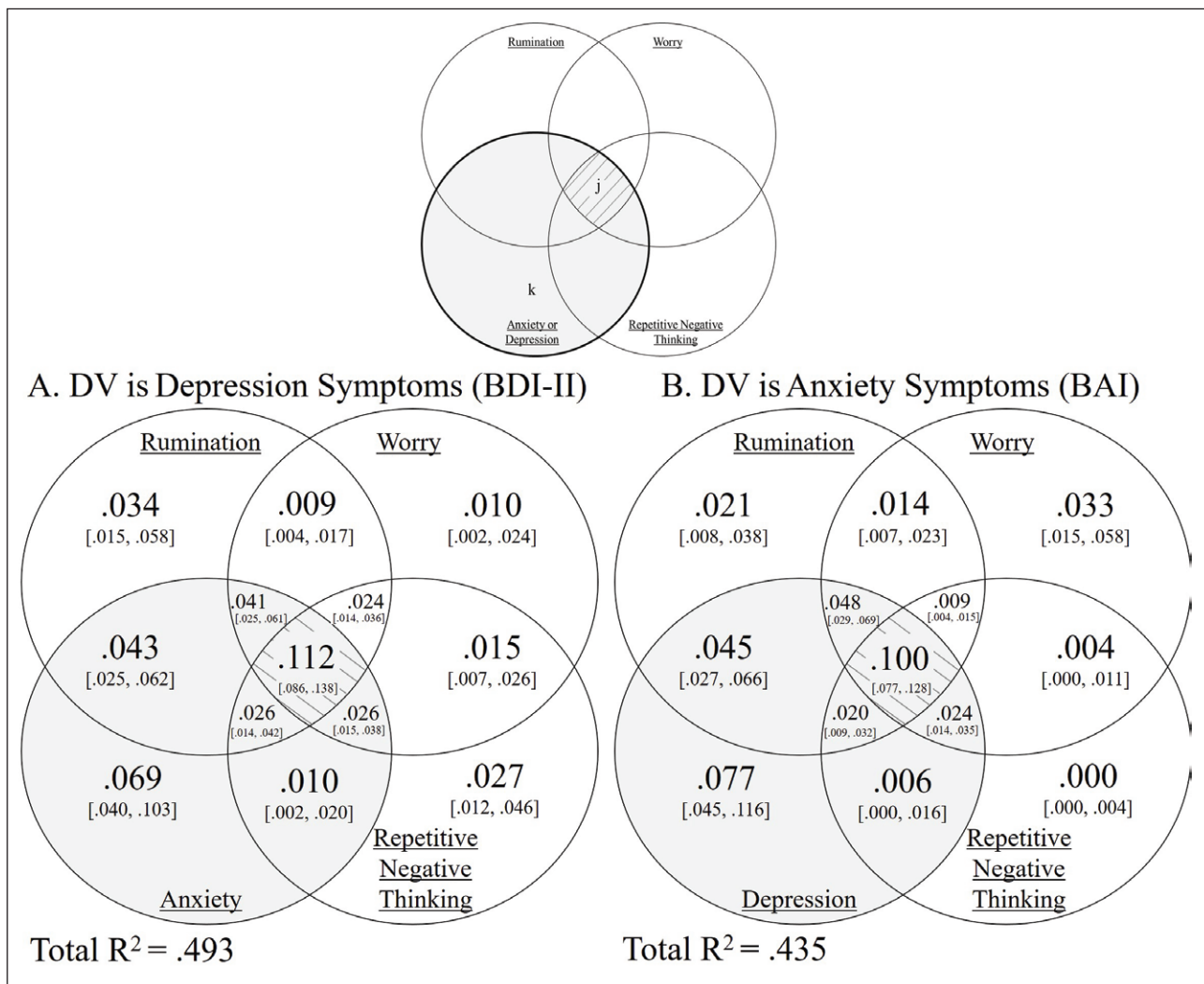
Figure 3: Commonality analyses for Hypothesis 2A involving rumination, worry, depression symptoms, and anxiety symptoms. Values inside each section of the diagram display the percent variation in repetitive negative thinking (HINT) that can be explained by each section. For example, the value furthest to the top left represents the variation in repetitive negative thinking uniquely explained by rumination (RRS), while the center-most value represents variation explained by variation shared with rumination, worry, depression, and anxiety. Two values are not shown in this model: the variation explained by the overlap between rumination and anxiety only (.000, CI [0.0%, 0.5%]) and the variation explained by the overlap between worry and depression only (.022, CI [1.1%, 3.5%]). The predictions displayed in Figure 1B are recreated on top for reference.

captured some rumination-specific and worry-specific variance as well.

Overlap with rumination, worry, depression and anxiety (Hypothesis 2A)

The commonality analysis involving rumination, worry, depression, and anxiety is displayed in **Figure 3**[5] (see **Table 3** for the corresponding R^2 values). Results supported the hypothesis that repetitive negative thinking would also account for covariation between depression and anxiety (Hypothesis 2A). Overall, 37.0% of the total variation in repetitive negative thinking was explained by the combination of rumination, worry, depression symptoms, and anxiety symptoms.[6] As shown in **Figure 3**, of the 16.0% of the variation in repetitive negative thinking that could be explained by the overlap between rumination and worry (the sum of the shaded regions, $d + e + f + g$, in **Figure 1B**), more than half of that variation (9.8%) was accounted for by the covariation between depression

and anxiety symptoms (section g, CI [7.3%, 12.3%]). In fact, this four-way overlap (9.8%) accounted for the largest portion of the total variance (37.0%) attributable to negative repetitive thinking illustrated in **Figure 3**. In contrast, little variation in repetitive negative thinking was explained by the component unique to rumination and worry (section d, 1.9%, CI [1.0%, 3.0%]), the component explaining the overlap between rumination, worry, and depression but not anxiety (section e, 3.2%, CI [2.0%, 4.6%]), or the component explaining the overlap between rumination, worry, and anxiety but not depression (section f, 1.0%, CI [0.5%, 1.7%]). The observation that the 95% bootstrapped CI for section g [7.3%, 12.3%] did not include any of the 95% CIs for the other sections (d, e, and f) suggests that, as hypothesized, most of the commonality between rumination and worry that can substantially explain the variation in negative repetitive thinking also overlaps with the commonality between depression and anxiety.

Figure 4: Commonality analyses for Hypothesis 2B, where the dependent measures (DVs) were the Beck Depression Inventory-II **(A)** or the Beck Anxiety Inventory **(B)** instead of the HINT. The shaded circle represents the total overlap between depression and anxiety symptoms. Two values are not shown in both models. In Figure A the overlap between rumination and repetitive negative thinking (.021, 95% CI [.011, .032]) and the overlap between worry and anxiety (.026, 95% CI [.013, .041]) are not displayed. In Figure B, the overlap between rumination and repetitive negative thinking (.001, 95% CI [.000, .005]) and the overlap between worry and depression (.033, 95% CI [.018, .050]) are not displayed. The predictions displayed in Figure **(C)** are recreated on top for reference.

The results shown in **Figure 3** also help quantify the variation in repetitive negative thinking uniquely attributable to depression or anxiety symptoms. As expected (Hypothesis 2A), depression symptoms explained only a small (but significant) portion of variation (section *h*, 3.3%, CI [1.5%, 5.7%], $p < .001$) after accounting for the overlap with other constructs, whereas anxiety symptoms explained no unique variation in repetitive negative thinking (section *i*, 0.0%, CI [0.0%, 0.4%], $p = .993$). Although these findings are consistent with the hypothesis that depression and anxiety symptoms are primarily associated with repetitive negative thinking through shared variance with worry and rumination, they additionally suggest that the HINT also captures some variance specific to depression.

Overlap with rumination, worry, depression and anxiety (Hypothesis 2B)

We also tested the complementary hypothesis that the overlap between depression and anxiety symptoms is also largely explained by the three-way overlap between repetitive negative thinking, rumination, and worry (Hypothesis 2B). Specifically, we performed two parallel analyses, one using depression symptoms (**Figure 4A**) and the other using anxiety symptoms as the dependent measure (**Figure 4B**). **Table 4** summarizes the R^2 values corresponding to **Figure 4A** and **4B** (the logic behind calculating those variance components are identical to those used for **Figure 3** and explained in Footnote 6).

In the analysis with depression symptoms as the dependent measure (**Figure 4A**), anxiety symptoms accounted for 35.3% of the variance in depression symptoms (the shaded portion). As expected, only a small but significant part of this covariation was due to variance unique to anxiety (section *k*, 6.9%, CI [4.0%, 10.3%], $p < .001$), and the remaining 28.4% was due to overlapping variance with rumination, worry, and/or repetitive negative thinking. As hypothesized, the joint overlap between anxiety symptoms, rumination, worry, and repetitive negative thinking (section *j*) explained the largest portion of variance in depression symptoms (11.2%, CI [8.6%, 13.8%]).

The results were nearly identical with anxiety symptoms as the dependent measure (**Figure 4B**). Depression symptoms accounted for 35.3% of the variance in anxiety symptoms (the shaded portion), but only 7.7%, CI [4.5%, 11.6%], $p < .001$, was unique to depression symptoms (section *k*). The joint overlap of rumination, worry, anxiety, and repetitive negative thinking (section *j*) explained the most variance in depression symptoms (10.0%, CI [7.7%, 12.8%]). The remaining 17.6% was explained by the shared variance between depression and at least one of the remaining three constructs. Thus, the results from these analyses are consistent with Hypothesis 2B.

Summary

These results were consistent with both study hypotheses. About half of the variance in repetitive negative thinking explained by rumination and worry was due to overlapping variance between rumination and worry (Hypothesis 1), although there was evidence for both rumination-specific

Table 4: R^2 Values for the Individual Models Used for Commonality Analysis for Hypothesis 2B in Study 1.

Predictors in Model	Model R^2
DV = Depression (Figure 4A)	
RRS + PSWQ + BAI + HINT	0.493
RRS + PSWQ + BAI	0.467
RRS + PSWQ + HINT	0.424
RRS + BAI + HINT	0.483
PSWQ + BAI + HINT	0.459
RRS + PSWQ	0.388
RRS + BAI	0.442
RRS + HINT	0.388
PSWQ + BAI	0.411
PSWQ + HINT	0.346
BAI + HINT	0.440
RRS	0.311
PSWQ	0.263
BAI	0.353
HINT	0.261
DV = Anxiety (Figure 4B)	
RRS + PSWQ + BDI-II + HINT	0.435
RRS + PSWQ + BDI-II	0.435
RRS + PSWQ + HINT	0.358
RRS + BDI-II + HINT	0.402
PSWQ + BDI-II + HINT	0.414
RRS + PSWQ	0.352
RRS + BDI-II	0.398
RRS + HINT	0.292
PSWQ + BDI-II	0.413
PSWQ + HINT	0.293
BDI-II + HINT	0.367
RRS	0.257
PSWQ	0.265
BDI-II	0.353
HINT	0.165

Note. All model R^2 were significant ($p < .001$). HINT = Habit Index of Negative Thinking; RRS = Ruminative Responses Scale; PSWQ = Penn State Worry Questionnaire; BDI-II = Beck Depression Inventory-II; BAI = Beck Anxiety Inventory.

and worry-specific variance as well (**Figure 2**). Second, most of the overlapping variance between rumination and worry was also capturing covariance with depression and anxiety symptoms (Hypothesis 2A; **Figure 3**) and most of the covariance between depression and anxiety symptoms was due to common variance in rumination, worry, and repetitive negative thinking, especially their joint overlap

(Hypothesis 2B; **Figure 4**). Together, these results suggest that repetitive negative thinking indeed captures important transdiagnostic variance across depression and anxiety symptoms.

Study 2: Repetitive Negative Thinking, Intrusive Thoughts, and Mindfulness
Specifying the Nomological Network for Repetitive Negative Thinking

Although repetitive negative thinking is considered multifaceted (Ehring & Watkins, 2008; Watkins, 2008), the nomological network for this construct has not been well established. Prior research examining repetitive negative thinking has focused predominantly on its association with rumination and worry, thus neglecting other potentially relevant aspects of repetitive thinking. For example, the tendency to experience difficult-to-remove intrusive thoughts is positively correlated with depression and anxiety (Muris, Merckelbach, & Horselenberg, 1996; Wegner & Zanakos, 1994). Furthermore, among an unselected sample of college students, individual differences in intrusive thoughts were systematically related to the difficulty with successfully regulating previously relevant but no-longer-relevant information in working memory in independent, emotionally neutral laboratory tasks (Friedman & Miyake, 2004). Therefore, experiencing intrusive thoughts and the resulting attempts to suppress such thoughts may be an important component of repetitive negative thinking.

Similarly, there is some evidence that lower levels of mindfulness are associated with higher levels of rumination as well as repetitive negative thinking (Verplanken et al., 2007). Mindfulness-based interventions for depression and anxiety have had some success (Evans et al., 2008; Ma & Teasdale, 2004; Teasdale et al., 2000), in part because training people to focus their attention to the present moment prevents the escalation of repetitive negative thinking about past or future events (Teasdale, Segal, & Williams, 1995; Teasdale et al., 2000). Moreover, a critical element of mindfulness is "decentering" (Safran & Segal, 1990), which involves attending to one's thoughts and feelings without judgement, and may also reduce repetitive negative thinking. Therefore, individual differences in mindfulness may also be an important component of repetitive negative thinking.

If intrusive thoughts and/or mindfulness are associated with repetitive negative thinking, it would be important to test whether these associations are similar to those of rumination and worry. It is likely that variation in either construct is associated with repetitive negative thinking as a part of the same overlapping variation shared between rumination and worry. However, if intrusive thoughts or mindfulness predicts repetitive negative thinking above and beyond rumination and worry, such results would mean that repetitive negative thinking encompasses more than just the overlap between rumination and worry (Ehring & Watkins, 2008; Watkins, 2008). Stated differently, there may be aspects of repetitive negative thinking unique to intrusive thoughts or mindfulness, akin to the rumination-specific or worry-specific negative thinking identified by others (Spinhoven et al., 2015). Identifying such unique correlates of repetitive negative thinking would help better understand and specify the nature and nomological network of this emerging construct.

Study 2 Hypotheses
The Study 2 hypotheses (Hypotheses 3A & 3B) are graphically displayed in **Figure 1D**. We hypothesized that the frequency of experiencing unwanted intrusive thoughts as well as the inability to direct one's attention to the present moment (i.e., low levels of mindfulness) should be associated with repetitive negative thinking (Hypothesis 3A). To better understand and characterize the nature of repetitive negative thinking, we also examined whether there would be a substantial amount of unique overlap between repetitive negative thinking and either intrusive thoughts or mindfulness that goes beyond the substantial overlap expected for rumination and worry (Hypothesis 3B).

If intrusive thoughts or low levels of mindfulness are also captured by repetitive negative thinking (Hypothesis 3A), then a substantial amount of this rumination–worry overlap shared with the HINT (the shaded section in **Figure 1D**) should reflect the three-way overlap between rumination, worry, and intrusive thoughts or mindfulness (section *m* in **Figure 1D**), rather than the two-way overlap between rumination and worry only (section *l* in **Figure 1D**). Furthermore, to the extent that there is specific variation in repetitive negative thinking explained by intrusive thoughts or mindfulness (similar to the rumination-specific and worry-specific variances observed in Study 1 and summarized in **Figure 2**), this variance should be captured by section *n* (Hypothesis 3B).

Method
Participants
Analyses were based on the same data as Study 1. However, the measures of unwanted intrusive thoughts and mindfulness, respectively, were included in only two of the five samples (Samples 3 & 4 for intrusive thoughts and Samples 1 & 2 for mindfulness). Thus, analyses involving each construct were performed separately on a subset of the data ($n = 227$ and 233, respectively).

Measures
The tendency to experience and suppress intrusive thoughts was assessed (in Samples 3 and 4 only) with the 15-item White Bear Suppression Inventory (WBSI; Wegner & Zanakos, 1994). Example items included: "I have thoughts that I cannot stop," "There are thoughts that keep jumping into my head," and "I often do things to distract myself from my thoughts." Mindfulness was assessed (in Samples 1 and 2 only) using the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2008). Example items included: "I watch my feelings without getting lost in them," "I am easily distracted (reverse coded)," and "I can usually describe how I feel at the moment in considerable detail."

Table 5: R^2 Values for the Individual Models Used for Commonality Analysis for Hypothesis 3 in Study 2.

Predictors in Model	Model R^2
Thought Suppression (Figure 5A)	
RRS + PSWQ + WBSI	0.222
RRS + PSWQ	0.205
RRS + WBSI	0.157
PSWQ + WBSI	0.205
RRS	0.128
PSWQ	0.162
WBSI	0.109
Mindfulness (Figure 5B)	
RRS + PSWQ + FFMQ	0.403
RRS + PSWQ	0.325
RRS + FFMQ	0.321
PSWQ + FFMQ	0.384
RRS	0.146
PSWQ	0.302
FFMQ	0.247

Note. In all regressions, the dependent measure was the Habit Index of Negative Thinking. All model R^2 were significant ($p < .001$). RRS = Ruminative Responses Scale; PSWQ = Penn State Worry Questionnaire; WBSI = White Bear Suppression Inventory; FFMQ = Five Facet Mindfulness Questionnaire.

Data analysis

The overall R^2 estimates of the linear models for Study 2 are summarized in **Table 5**. In these analyses, bootstrapped 95% CIs were computed in the same way as in Study 1, except that, due to the smaller sample sizes, they were based on a random sample of 100 subjects per iteration (42.9% or 44.1% of the samples). The 95% CIs reported for Study 2 are considerably larger.

Results

Descriptive statistics, reliability estimates, and Pearson correlations between questionnaires for the measures of intrusive thoughts and mindfulness are also presented in **Tables 1** and **2**. As expected, repetitive negative thinking was positively associated with intrusive thoughts ($r = .34$) and negatively associated with mindfulness ($r = -.45$). Their correlations with rumination and worry were similar in magnitude.

Overlap with intrusive thoughts

The commonality analysis involving intrusive thoughts is displayed in **Figure 5A** (see **Table 5** for the corresponding R^2 values). Most of the correlation between repetitive negative thinking and intrusive thoughts could be explained by variation shared with rumination and worry (section *m*), explaining 5.4% of the variance in repetitive negative thinking, CI [2.3%, 9.5%]. After accounting for intrusive thoughts, the overlap between rumination and worry explained (3.1%) of the variance in repetitive negative thinking (section *l*), CI [0.6%, 6.2%]. As hypothesized, these results suggest that much of the overlap between rumination and worry that predicts repetitive negative thinking is also shared with tendencies to experience and suppress unwanted intrusive thoughts (Hypothesis 3A).[7] There was also a small but still statistically significant amount of variance in intrusive thoughts explaining repetitive negative thinking above and beyond that shared with rumination and worry (section *n*, 1.7%, CI [0.0%, 6.5%]), $p = .030$. This finding supports Hypothesis 3B, that there may be some intrusive thought-specific variance captured in the HINT above and beyond that shared with rumina-
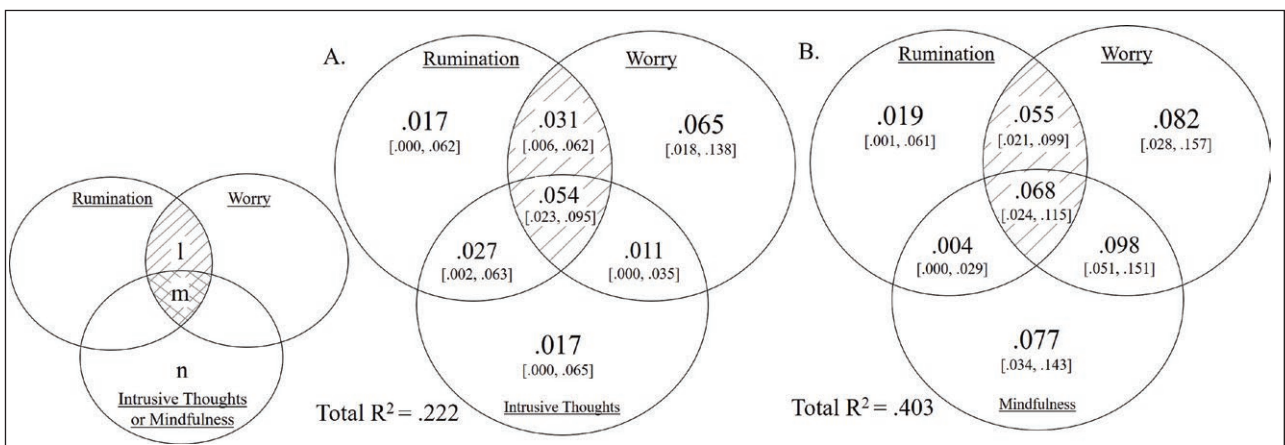
Figure 5: Commonality analyses for Hypothesis 3 involving rumination, worry, and intrusive thoughts **(A)**, and rumination, worry, and mindfulness **(B)**. Values inside each section of the diagram display the percent variation in repetitive negative thinking (HINT) that can be explained by each section. For example, the value furthest to the top left of Figure A represents the variation in repetitive negative thinking uniquely explained by rumination, while the center-most value represents variation in repetitive negative thinking explained by variation shared with rumination, worry, and mindfulness. The predictions displayed in Figure 1D are recreated on the bottom left for reference.

tion and worry, although the effect was rather small. In total, 22.2% of the variance in the HINT was explained by rumination, worry, and intrusive thoughts.

Overlap with mindfulness
The results of the commonality analysis involving mindfulness (see **Figure 5B**) confirmed that much of the correlation between repetitive negative thinking and mindfulness reflected variance shared with rumination and worry, explaining 6.8% of the variance in repetitive negative thinking, CI [2.4%, 11.5%], (section *m*).[8] After accounting for mindfulness, the overlap between rumination and worry still explained 5.5% of the HINT, CI [.021, .099] (section *l*). Mindfulness alone explained an extra 7.7%, CI [3.4%, 14.3%], of the variation in repetitive negative thinking that was not accounted for by rumination and/or worry (section *n*), *p* < .001. In total, 40.3% of the variance in the HINT was explained by rumination, worry, and mindfulness. These results suggest that, consistent with Hypothesis 3A, most of the overlap between rumination and worry that predicts repetitive negative thinking was also explained by individual differences in mindfulness. At the same time, consistent with Hypothesis 3B, repetitive negative thinking may also substantially capture some mindfulness-specific variance that does not overlap with rumination and/or worry.

Summary
Consistent with Hypothesis 3A, much (if not most) of the overlap between repetitive negative thinking and intrusive thoughts or mindfulness was captured by shared variance with rumination and worry (section *m*). Additionally, consistent with Hypothesis 3B, there were unique associations between repetitive negative thinking and mindfulness (7.7%), as well as between repetitive negative thinking and intrusive thoughts (1.7%), above and beyond their shared variance with rumination and worry (section *n*).

General Discussion
The primary goal of the current research was to shed new light on the nature of repetitive negative thinking and its associated constructs by focusing on overlap among these constructs, rather than the variance unique to each construct. For this purpose, we used commonality analysis to decompose variation in repetitive negative thinking into multiple sources, providing unique information about the nature of the overlap between repetitive negative thinking and other related constructs like depression and anxiety symptoms, rumination, and worry (Study 1). We also quantified the extent to which the covariation between depression and anxiety symptoms are attributable to repetitive negative thinking, rumination, worry, and their overlap (Study 2). Results supported the hypothesized associations between repetitive negative thinking, worry, rumination, and the covariation between depression and anxiety symptoms (Hypotheses 1 and 2). We also showed that repetitive negative thinking was associated with intrusive thoughts and low levels of mindfulness largely due to the same variance shared with worry and rumination, but also with some mindfulness-specific variance

(Hypothesis 3). Here, we discuss the implications of our results for future empirical work and theoretical development on repetitive negative thinking.

Transdiagnostic Nature of Repetitive Negative Thinking
Consistent with Hypothesis 1, the results demonstrated that repetitive negative thinking largely reflects overlapping variance between rumination and worry, but also reflects some rumination-specific and worry-specific variance (**Figure 2**). As reviewed earlier, Spinhoven et al.'s (2015) work suggested that a different measure of repetitive negative thinking, the PTQ, can capture the general overlap between rumination and worry in combined community and clinical samples recruited in the Netherlands. Our findings extend these results by showing that the HINT also assesses the general aspects of repetitive negative thinking shared between rumination and worry in an unselected sample of college students recruited in the United States.

Given these results, scales such as the HINT may be useful in examining how repetitive negative thinking is associated with other relevant mental and physical health outcomes. Scales that measure rumination and worry were developed to tap the thought-based components of depression and anxiety, respectively, and, as such, assess for negative thinking in specific contexts (e.g., rumination is past-oriented and worry is future-oriented). Insofar as they do not directly ask about specific past- or future-oriented or mood-specific negative thinking, the HINT and other questionnaires (e.g., PTQ, RTQ) may be useful measures to include in future research examining how and why certain individuals are predisposed to engage in repetitive negative thinking more generally.

Another aim of the study was to further understand whether the high rates of comorbidity between depression, anxiety, and other psychopathologies can be explained by general tendencies to experience perseverative thoughts (Ehring & Watkins, 2008; Watkins, 2008). The findings reported here advance our understanding of the nature of the associations between depression and anxiety in three important ways. First, consistent with Hypothesis 2A, most of the joint overlap between rumination and worry that explained repetitive negative thinking (16.0%) primarily reflected variation also shared with both depression and anxiety (9.8%, section *g* in **Figure 3**). Only 1.9% of that variation in repetitive negative thinking between rumination and worry (16.0%) was unrelated to either depression or anxiety symptoms (section *d*). These results suggest that the experience of depression and anxiety symptoms are at the core of the overlap between rumination and worry in their relation to general tendencies for repetitive negative thinking.

Second, no variation in repetitive negative thinking (0.0%) was explained by variation unique to anxiety symptoms (section *i* in **Figure 3**), and only a small amount (3.3%) was explained by variation unique to depression symptoms (section *h*). These results suggest that measures of repetitive negative thinking do not capture any unique variation in anxiety symptoms except those

aspects directly associated with rumination and/or worry. Although there was some evidence that depression symptoms were associated with repetitive negative thinking above and beyond rumination and worry, the clear majority of its association with the HINT was explained by overlapping variance with the other constructs (3.3% unique vs. 26.1% of the total variance explained by depression symptoms). Nevertheless, it may be important to examine in future research what specific aspects of depression symptoms may be associated with repetitive negative thinking above and beyond rumination and worry.

Third, and perhaps most important, when depression symptoms were used as the dependent measure (**Figure 4A**), most of the variance shared with anxiety symptoms (the shaded portion) was also shared with rumination, worry, and repetitive negative thinking, and only a small portion (section *k*) was unique to anxiety (and vice versa when anxiety symptoms were used as the dependent measure, as shown in **Figure 4B**). These results are consistent with the hypothesis that repetitive negative thinking should account for most of the overlap between symptoms of depression and anxiety (Hypothesis 2B).

This study is one of the first to directly quantify the proportion of the overlap between depression and anxiety symptoms that can be directly attributed to repetitive negative thinking and suggests that there is little variance unique to anxiety that predicts depression (and vice-versa) above and beyond rumination, worry, and/or repetitive negative thinking. These findings are consistent with recent work (reviewed by Eysenck & Fajkowska, 2017) suggesting that rumination and worry show some distinct associations (e.g., with later increases in negative affect for rumination only or increased cortisol in worry only), but limited evidence for unique associations between depression and rumination independent of variation in anxiety and/or worry and vice versa (Kircanski, Thompson, Sorenson, Sherdell, & Gotlib, 2017; Lewis, Yoon, & Joormann, 2017). Therefore, although worry and rumination certainly have unique variance, the underlying processes that generate both may be central to the shared variance in depression and anxiety.

Relations with Intrusive Thoughts and Mindfulness

Repetitive negative thinking has typically been studied in the context of rumination and worry, even though it may more broadly be explained by a number of constructs including perseverative cognition and counterfactual thinking (Watkins, 2008). Indeed, even in the model with depression and anxiety (**Figure 3**), only 37% of the variance in repetitive negative thinking was accounted for by the four predictors. This study extends research on repetitive negative thinking by revealing its associations with two other related constructs: unwanted intrusive thoughts and mindfulness.

First, these results suggest that the association between intrusive thoughts and repetitive negative thinking was due to variance shared with rumination and worry (Hypothesis 3A), and that only a small but significant portion of thought suppression explained variation in repetitive negative thinking above and beyond rumination and worry (weakly supporting Hypothesis 3B). These results make sense given that the items on the WBSI assess general unwanted thoughts, distraction, and thought suppression (e.g., *I have thoughts that I cannot stop*, *I often do things to distract myself from my thoughts*), and do not draw as strongly on specific situations as the measures of rumination and worry (e.g., like past-oriented ruminations and future-oriented worries in the RRS and PSWQ, respectively). Therefore, the experience and suppression of unwanted intrusive thoughts may be more strongly related to repetitive negative thinking than specific types of negative thinking.

Second, our findings suggest that having low levels of mindfulness is an important, general aspect of repetitive negative thinking shared with rumination and worry (Hypothesis 3A). However, mindfulness also explained a substantial amount of unique variation in repetitive negative thinking (7.7%; section *n* in **Figure 5B**), suggesting that some aspects of mindfulness are integral parts of repetitive negative thinking that are not captured when focusing on rumination and worry alone (Hypothesis 3B). To the extent that mindfulness involves non-judgmental attitudes towards negative emotions and rumination/ worry involve judgmental attitudes, we might expect these to be captured by their common variance (i.e., they are two sides of the same coin). A similar argument can be made for the fact that mindfulness represents attending to the present moment instead of the past or future (as in rumination/worry). If so, it is unclear what factor comprise the mindfulness-specific variance in repetitive negative thinking that was unique from worry and rumination, but this may reflect the "observant" facet of mindfulness (i.e., noticing external details such as sights, sounds, or smells, or internal thought and emotions), as this facet is less obviously the opposite of rumination/worry as the non-judgment, non-reactive, describing, or awareness of the present moment aspects of mindfulness assessed in the five facet model here (Baer et al., 2008).

Taken together, these results (especially those related to Hypothesis 3B) suggest that repetitive negative thinking, at least as measured with the HINT, goes beyond simply the shared variance between rumination and worry. To better characterize the nature and nomological network of negative repetitive thinking, further research of the kind presented here is necessary that involves other constructs related to repetitive negative thinking (e.g., counterfactual thinking; Watkins, 2008).

Broader Theoretical Implications

More broadly, our findings are relevant to the intersection of cognition and psychopathology. Although this study examined repetitive negative thinking with respect to depression and anxiety symptoms only, it may also underlie other related internalizing disorders, such as posttraumatic stress disorder or obsessive-compulsive disorder, both of which implicate repetitive negative thoughts. Given the substantial overlap between internalizing and externalizing disorders, it is also possible that repetitive negative thinking may share some underlying commonality with some externalizing disorders as well

(Caspi et al., 2014; Ciesla et al., 2011). Thus, understanding whether tendencies for repetitive negative thinking exist at the level of common variance between internalizing and externalizing disorders (e.g., the so-called *p*-factor), broadband-specific variance (e.g., between anxiety and depression), and/or thought-content-specific variance (i.e., worry-specific variance in anxiety) may be vital to advance theoretical models of cognitive dysfunction in psychopathology.

In fact, there is some evidence that other cognitive processes, especially executive functions, are transdiagnostic features of psychopathology. Indeed, executive functions—goal-directed control processes that regulate thoughts and action (Friedman & Miyake, 2017; Miyake & Friedman, 2012)—are impaired in trait anxiety (Eysenck et al., 2007), clinical depression (Snyder, Miyake, & Hankin, 2015), and other aspects of externalizing disorders (Caspi et al., 2014; Gustavson et al., 2017). Furthermore, there is some evidence suggesting that cognitive aspects of depression and anxiety (i.e., rumination and worry) underlie these associations with executive functions (Altamirano, Miyake, & Whitmer, 2010; Eysenck et al., 2007; Gustavson & Miyake, 2016). Thus, examining the overlap between repetitive negative thinking and executive functions may be helpful in further understanding how cognitive processes underlie shared variance across psychopathology.

Limitations of the Study

Although the current study provided support for our hypotheses regarding negative repetitive thinking, these findings should be interpreted in the context of the following limitations. First, we examined repetitive negative thinking with only one measure, the HINT. Future work should use other measures of repetitive negative thinking, such as the PTQ or RTQ, and analyze the results at the level of latent variables. In particular, because the HINT was developed as a measure of *habitual* negative thinking, including other measures of negative repetitive thinking within the same study should be informative in specifying the extent to which the shared variance identified in this study reflects different facets of negative repetitive thinking postulated in the literature, such as habitual thinking (e.g., automaticity), perseverative thinking (e.g., frequency), and/or uncontrollable thinking (e.g., inability to stop).

Second, because intrusive thoughts and mindfulness were assessed in only two of the five samples, these results are based on smaller samples and therefore should be interpreted with some caution. For this reason, the 95% bootstrapped CIs for Study 2 were necessarily considerably wider than those computed for Study 1 and hence were less informative. The total amount of variance accounted for by rumination and worry (for the HINT) was also lower in these analyses compared to the full sample (**Figure 5**), suggesting that the results for intrusive thoughts and mindfulness described here may be underestimated.

Third, associations were observed in a college-student sample not screened for elevated levels of depression or anxiety symptoms, and hence the results may not generalize across all levels of depression/anxiety severity.

Fourth, consistent with our hypothesis (2A), no variation in repetitive negative thinking was explained by variation unique to anxiety, but it was possible that this may have been driven by the fact that the BAI oversamples panic symptoms rather than other aspects of anxiety (Cox, Cohen, Direnfeld, & Swinson, 1996). The results may have differed if other measures of anxiety were administered, such as those of generalized anxiety disorder. However, to the extent that other measures of anxiety better capture worry and repetitive thinking, we would still expect that this variance would be captured by the overlap between anxiety, worry, and repetitive thinking (e.g., section *g* in **Figure 3**), rather than variation unique to anxiety (section *i*).

Finally, this study represented a secondary data analysis of data collected for other purposes. The sample size for the entire sample (Study 1) was reasonably large (*N* = 643), but the five studies differed somewhat in the specific tasks and measures administered to the participants (for detailed information, see Footnotes 2 and 3). Therefore, one might question the generalizability of the results across different samples. Although the general similarity of the patterns of correlations across the five samples (see Table S1) somewhat counters this concern, we have also conducted the same commonality analyses reported above for each of the five samples. Those results are briefly summarized in Table S2 in Appendix B, listing the range of the variance estimates across five samples for the key variance components listed in **Figures 2–5** and labeled with letters (*a* to *n*) in those figures. As can be seen in Table S2, the component estimates derived from the five individual samples showed some ranges (perhaps as expected, given that small sample sizes lead to less accurate estimates), the results are sufficiently consistent across the five samples included in the current study, although a replication with independent samples will be an important future endeavor.

Concluding Remarks

In conclusion, the current study used a novel approach (commonality analysis) to test hypotheses regarding repetitive negative thinking. Specifically, our results support a substantial association between repetitive negative thinking and the shared variation between measures of rumination and worry, suggesting that there may be utility in focusing on repetitive negative thinking in future research, rather than treating rumination and worry as separate constructs and examining them separately. Moreover, we also demonstrated how repetitive negative thinking (as measured by the HINT) accounts for much of the covariation between depression and anxiety symptoms. These findings suggest that repetitive negative thinking may be an important transdiagnostic construct that helps advance our understanding of depression, anxiety, and, possibly, other types of psychopathology. Finally, we provided new evidence for associations between repetitive negative thinking and both unwanted intrusive thoughts and

mindfulness, suggesting that both constructs are essential to our growing understanding of the nomological network of traits captured by repetitive negative thinking. As these results illustrate, we submit that the commonality analysis approach used in the current study will be useful in future studies in clinical psychology in quantifying the contributions of overlapping variance components that are often ignored in more typical regression analyses.

Data Accessibility Statements
The raw questionnaire data, aggregate scores for individual questionnaires, and analysis scripts (in R) are available for download at https://osf.io/9gmnj/ as online supporting information.

Additional Files
The additional files for this article can be found as follows:

- **Appendix A.** Table S1: Correlations Between the HINT and the Other Measures Included in the Study for the Five Subsamples. DOI: https://doi.org/10.1525/collabra.128.s1
- **Appendix B.** Table S2: Range of Results for the Labelled Sections of Figure 1 (Sections a–n) Separated by Sample. DOI: https://doi.org/10.1525/collabra.128.s2

Notes
1 The only inclusion criterion was that participants complete all questionnaire measures included in the study. Six participants who took part in one of the studies were excluded because they did not complete one or more of the questionnaires analyzed here.

2 For full disclosure, we note that some studies included extra trait-level questionnaires: the Index of Depression and Anxiety Symptoms (Watson et al., 2007) in Samples 1 and 2, the State-Trait Anxiety Inventory (Spielberger, 1983) in Sample 3, and the arousal subscale of the Mood and Anxiety Symptom Questionnaire (Keogh & Reidy, 2000) in Sample 4. These questionnaires were excluded from the current analysis because they are limited to one sample or overlapped with other constructs assessed in all samples.

3 In Sample 1 (n = 118), participants performed an asymmetric task-switching task, the goal-neglect Stroop, and a thought suppression task (Gustavson, Altamirano, Johnson, Whisman, & Miyake, 2017a). In Sample 2 (n = 115), participants completed a working memory updating task involving the memorization and later removal of short lists of word stimuli (Gustavson & Miyake, 2016). The study involving Sample 3 was a pilot study for the main study involving Sample 4 that was reported as part of a Master's thesis (Gustavson, 2013). The tasks performed by participants in Samples 3 (n = 75) and 4 (n = 152) were nearly identical to those used in the Gustavson and Miyake (2016) study (Sample 2), but also included measures of working memory span and a new experimental condition in the working memory

updating task. Participants in Sample 5 (n = 183) conducted a task-switching task and a working memory updating task.

4 The algebraic decompositions shown in **Figure 2** are computationally simple. The unique variance components in **Figure 2** were computed by subtracting the R^2 values in the models with rumination alone (.229) or worry alone (.261) from the R^2 value in the full model (.331). The shared area (b) was computed by subtracting unique variance components from the R^2 value in the full model (.331 – .070 – .102). Note that these estimates can be slightly different from the estimates in the main text due to rounding of the R^2 values.

5 For simplicity, two variance components are not shown in **Figure 3**: (a) the two-way overlap between rumination and anxiety (.000) and (b) the two-way overlap between depression and worry (.022).

6 The calculation of the individual variance components followed the same logic as that used for the simpler model in **Figure 2**, but multiple steps were involved. First, unique variance components (e.g., unique to worry) were computed by comparing the R^2 of the full model with the R^2 of the model excluding that trait (e.g., .370 – .320). Variance components representing two-way overlaps (e.g., an overlap between rumination and worry) were computed by taking the R^2 of the full model and subtracting the unique variance components for those constructs as well as the R^2 of the model with the two other traits: .370 – .024 (unique rumination) – .050 (unique worry) – .278 (R^2 of the model including depression and anxiety only) = .019. Three-way variance components (e.g., rumination, worry, depression) were computed by taking the R^2 of the full model and subtracting the unique variance components of those constructs, the two-way variance components between those constructs, and the R^2 of the model of the excluded trait: .370 – .024 (unique rumination) – .050 (unique worry) – .033 (unique depression) – .019 (two-way rumination/worry) – .025 (two-way rumination/depression) – .022 (two-way worry/depression) – .165 (R^2 of anxiety only). Finally, the center portion (estimated at .098) was computed by subtracting all other variance components from the R^2 of the full model with rumination, worry, anxiety, and depression. In some cases, these estimates are slightly different from the estimates in the main text due to rounding of the R^2 values in **Tables 2, 3,** and **4**.

7 Some previous work has decomposed the WBSI into subscales focusing on items related to unwanted thoughts (Friedman & Miyake, 2004), or intrusive thoughts versus thought suppression (Schmidt et al. 2009). Reanalysis of the current WBSI data using only items in each of these three subscales revealed the same patterns of results, suggesting that these associations remain similar regardless of whether we focus on unwanted thoughts, intrusive thoughts, or thought suppression.

8 Unexpectedly, although this was not the focus of the study, there was also variance shared between mind-

fulness and worry but with not rumination, explaining another 9.8% of the HINT, CI [.051, .151].

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Competing Interests
The authors have no competing interests to declare.

Authors Contributions
- Contributed to conception and design: DEG, AD, MAW, AM
- Contributed to acquisition of data: DEG, AM
- Contributed to analysis and interpretation of data: DEG, AD, MAW, AM
- Drafted and/or revised the article: DEG, AD, MAW, AM
- Approved the submitted version for publication: DEG, AD, MAW, AM

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