

Visual and Verbal Depressive Cognition: Implications for the Rumination– Depression Relationship

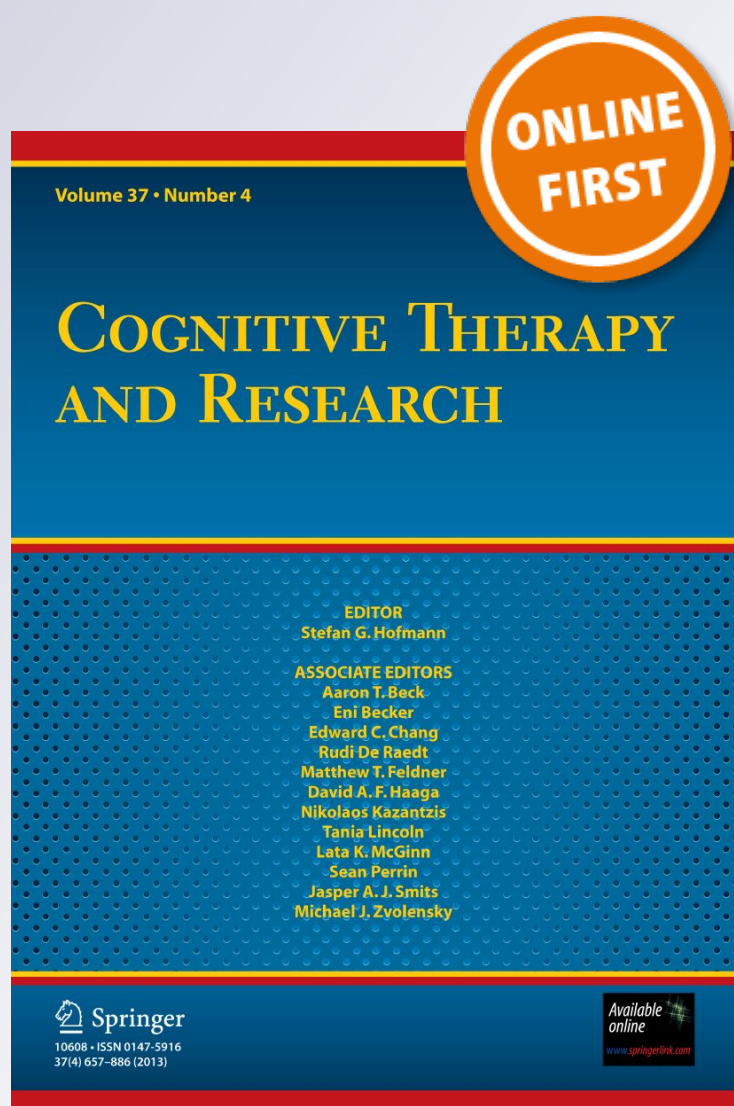
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Visual and Verbal Depressive Cognition: Implications for the Rumination–Depression Relationship

Hannah R. Lawrence¹ · Emily A. P. Haigh¹ · Greg J. Siegle² · Rebecca A. Schwartz-Mette¹

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Abstract

The present studies evaluated whether experiencing depressive cognition as visual (i.e., in the form of visual mental imagery) or verbal (i.e., in the form of verbal thought) was differentially associated with the strength of the rumination–depression relationship. Visual mental imagery is consistently found to be more emotionally arousing than verbal thought. This may especially be the case when individuals dwell on their visual or verbal depressive cognition in the form of depressive rumination. In Study 1, 41.2% of participants reported a visual depressive cognitive style and 57.1% reported a verbal depressive cognitive style. For both males and females, rumination was associated with similarly severe depressive symptoms when individuals reported experiencing visual depressive cognitions compared with verbal depressive cognitions. Study 2 replicated and extended Study 1, taking into account that some individuals may experience depressive cognition both visually and verbally. 23.8% of participants reported a visual depressive cognitive style, 38.9% a verbal depressive cognitive style, and 37.3% a both visual and verbal depressive cognitive style. Rumination was significantly associated with depressive symptom severity for all depressive cognitive styles (visual, verbal, both), though depressive cognitive style significantly moderated the relationship between rumination and depressive symptom severity such that there was a stronger relationship for individuals who had a visual depressive cognitive style than a verbal depressive cognitive style, especially for females. Findings suggest that dwelling on depressed affect (i.e., rumination) may be more strongly related to depressive symptom severity when individuals tend to experience depressive cognitions as visual. Examination of depressive cognition as both visual and verbal is necessary to fully understand how individuals think about their depressed affect and may eventually inform tailoring of interventions based on visual/verbal styles of depressive cognition.

Keywords Rumination · Depression · Mental imagery · Visual depressive cognition · Verbal depressive cognition

Rumination, defined here as repeatedly dwelling on negative cognitions, is a well-established risk factor for depression. Individuals who engage in rumination think perseveratively about their depressed mood and related negative events, which over time exacerbates distress. This maladaptive strategy to regulate one's emotions predicts onset of depressive episodes (Nolen-Hoeksema 2000), more severe depressive symptoms over time (e.g., Nolen-Hoeksema and Davis 1999; Nolen-Hoeksema and Morrow 1991), and increased chronicity of depression (Nolen-Hoeksema 2000). Despite a large

literature on associations between rumination and depression, little is known about how rumination may differentially relate to depression depending on whether individuals tend to experience their depressive cognitions visually or verbally (defined here as depressive cognitive style).

To date, researchers have nearly exclusively conceptualized rumination as a verbal process (Fresco et al. 2002), with individuals dwelling on negative affect in the form of verbal depressive cognitions. Given the role mental imagery plays in many mental health disorders (e.g., flashbacks in post-traumatic stress disorder), and more recent research suggesting that rumination can be high in sensory qualities (McLaughlin et al. 2007; Newby and Moulds 2012; Pearson et al. 2008; Watkins et al. 2005), it is possible that some individuals may ruminate visually (i.e., dwell on depressive cognitions in the form of visual mental images), however.

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What is more, to our knowledge, no research has evaluated whether rumination differentially relates to depression depending on whether individuals tend to experience visual or verbal styles of depressive cognition. If rumination is more closely tied to depression when individuals experience their depressive cognitions visually compared with verbally, it may be beneficial to specifically assess for depressive cognitive style (visual, verbal), and match visually- or verbally-focused intervention strategies accordingly. The present series of studies examined the prevalence of visual and verbal styles of depressive cognition and evaluated whether the strength of the relationship between rumination and depressive symptoms varied based on whether individuals tend to experience depressive cognitions visually, verbally, or both visually and verbally.

Visual Imagery and Depression

Cognitive behavioral theorists have long posited that depressive cognitions may take the form of verbal thoughts or visual mental images (Beck 1976), yet surprisingly few studies have examined visual mental images in depression. Research that has examined mental images and depression suggests that depressive mental images are in fact common. Williams and Moulds (2007) asked a non-clinical sample of college students about their experience with intrusive memories. They found that over 75% of intrusive memories that participants reported had visual qualities, either in isolation or in combination with other sensory modalities (e.g., auditory). Similarly, Watkins et al. (2005) had a non-clinical sample of participants complete the Cognitive Intrusion Questionnaire (Freeston et al. 1992), a self-report measure that evaluates intrusive thoughts, images, or impulses, which includes questions about the percentage of verbal content and mental images. Watkins et al. reported that only 43.4% of their sample experienced verbal intrusive cognitions, which suggests that the remaining 56.6% of participants may have non-verbal, sensory-rich intrusive cognitions of some kind. More specific to depression, 27.2% (Moritz et al. 2014) to 44% (Patel et al. 2007) of individuals with major depressive disorder (MDD) report that their depressive cognitions have at least some visual properties.

Negative mental imagery is not only common in depression but may also be linked with the pathogenesis of depression (e.g., Holmes et al. 2009a; Williams and Moulds 2007). When collapsed across sensory modalities (visual, auditory, tactile, somatic, olfactory), Moritz et al. (2014) found that participants with sensory-rich depressive thoughts had more severe depressive symptoms, a greater number of depressive episodes, and were hospitalized more frequently than those without sensory-rich depressive thoughts. Although this finding cannot be confined to depressive visual mental

images specifically, it does suggest that sensory-rich depressive cognitions (such as visual mental images) may serve as a risk factor for depression over and above verbal thoughts.

In addition, research has shown that individuals with depression may have a specific bias towards generating negative mental images. Individuals higher in depressive symptoms have been shown to experience greater difficulty generating vivid positive mental images compared to individuals lower in depressive symptoms, suggesting that depression may also be associated with a lack of positive imagery (Anderson and Evans 2015; Stöber 2000; Szöllösi et al. 2015). At the same time, depressed individuals were as capable as non-depressed individuals at generating vivid negative mental images (Stöber 2000) and may in fact be able to generate more vivid negative mental images compared to individuals lower in depressive symptoms (Szöllösi et al. 2015). Taken together, research suggests that some individuals with depression may experience vivid negative mental images while having an impaired ability to generate equivalent positive mental images, though more research is needed to clarify the role of visual mental imagery in depression.

Visual and Verbal Depressive Cognition and Rumination

Although it does appear that depressive cognition can take the form of visual mental images (e.g., Williams and Moulds 2007), less research has specifically examined rumination in the form of visual depressive cognition. Rumination has predominately been described as a verbal thought process (e.g., Fresco et al. 2002), though more recent work suggests that rumination may in fact occur in visual form. Pearson et al. (2008) interviewed chronically depressed individuals about the frequency with which they ruminate, the average length of an episode of rumination, the topics on which they ruminate, and importantly, whether their ruminative cognitions took the form of verbal thoughts or if their ruminative cognitions had other sensory qualities. Pearson et al. found that among this clinically depressed sample, 72.7% of participants reported that their ruminative cognitions involved sensory qualities of some kind (e.g., imagery, olfactory, auditory).

Similarly, Newby and Moulds (2012) interviewed adults with MDD about their ruminative cognitions. Among other questions regarding the frequency and content of rumination, participants were asked to indicate whether they experienced rumination like a verbal thought, like a feeling, or like a sensory experience. If they reported that their ruminative cognitions were like a sensory experience, they further indicated whether these ruminations were like a visual image (i.e., seeing a movie scene or seeing a snapshot), sounds (other than words), as if hearing words or sentences that

were spoken, bodily sensations, or smells. In total, 94.7% of the sample reported some sensory components to their ruminative cognitions, with 52.6% reporting that their ruminative cognitions included visual mental images. Of note, participants were instructed to select as many categories as fit; thus, participants who indicated that their ruminative cognitions included visual mental images may have also selected additional sensory or verbal qualities to their cognitions.

In the only study to date to examine visual and verbal qualities of induced rumination, McLaughlin et al. (2007) had participants ruminate on three topics about which they reported to frequently ruminate. Every 60 s during the induction participants rated the extent to which their rumination involved thoughts, images, or both. With a sample of non-clinical adults (Study 1), 60.53% reported that their rumination involved verbal thoughts, 35.92% mental images, and 3.55% neither verbal thought nor mental images. With a sample of high trait worriers/ruminators (Study 2), 70.57% reported that their rumination involved verbal thoughts, 27.27% mental images, and 2.16% neither verbal thought nor mental images.

Visual and Verbal Depressive Cognition and Worry

Given that both rumination and worry are forms of repetitive negative thinking (RNT), it is important to consider how theories of mental imagery and worry may inform what is hypothesized regarding mental imagery and rumination. According to Borkovec's Cognitive Avoidance Model, worry is predominately a verbal thought process (Borkovec 1994; Borkovec et al. 1998, 2004). Borkovec and colleagues propose that when worrying, individuals tend to persevere on future-oriented negatively valenced verbal thoughts, while imagery is less frequently present. This model is supported by research suggesting that both non-anxious and anxious individuals report an increase in verbal thought and a decrease in mental imagery when induced to worry (e.g., Behar et al. 2005; Borkovec et al. 1998; Borkovec and Inz 1990; Stöber 2000). Additionally, only verbal tasks (rather than visuo-spatial tasks) appear to interfere with worry (Rapee 1993), which again indicates that worry is likely a verbal process. Borkovec hypothesizes that worry serves a protective role, shielding the individual from more emotionally and physiologically arousing mental imagery.

More recent work (see Goodwin et al. 2017) provides further support for the notion that worry is not only a verbal process but may be especially impairing because of its verbal nature. In their review, Goodwin et al. 2017 found that individuals with anxiety show a significant attentional bias to threat when presented with verbal stimuli but not visual stimuli (Goodwin et al. 2017). Additionally, at least for high worriers, worrying verbally depletes attentional

control resources more so than worrying in the form of mental imagery (Leigh and Hirsch 2011).

Based on these findings for worry, one might expect that rumination too would be a predominately verbal process. Rumination and worry are commonly distinguished by their focus on the past (in the case of rumination) or future (in the case of worry), however. This may be an especially important distinction in the context of the present investigation given that depressive cognitions about the past could be accompanied with visual content encoded at the time of the event. Depressive cognitions focused on the future, however, would require construction of novel visual content, which may be less likely given the cognitive demands of perseverative cognition. Additionally, research has suggested that rumination may be associated with experiential avoidance (Thomas et al. 2015) whereas worry may be conceived as a process to avoid abrupt changes in affect (i.e., the contrast avoidance model; Newman and Llera 2011). It is therefore possible that rumination in the form of mental imagery still allows the individual to behaviorally avoid emotionally arousing situations, whereas worrying in the form of mental imagery would elicit too great a shift in negative affect and therefore remains verbal.

Although yet to be explored fully, there is evidence that individuals induced to ruminate experience increases in mental imagery and decreases in verbal thought (McLaughlin et al. 2007), which is in contrast to findings for worry. In the McLaughlin and colleagues study, participants in both samples reported decreases in verbal thought and increases in mental imagery from pre- to post-rumination. This research along with numerous studies evidencing the prevalence of visual forms of rumination (e.g., McLaughlin et al. 2007; Newby and Moulds 2012; Pearson et al. 2008; Williams and Moulds 2007) suggest that rumination may be more susceptible to perseveration on visual mental images compared with worry, which appears to be more characteristically verbal. Although research has demonstrated the existence of visual forms of rumination, further examination of how rumination may differentially relate to depressive symptom severity depending on whether individuals tend to have visual or verbal depressive cognitions is needed.

Comparing Visual Mental Images and Verbal Thoughts

What research exists on visual mental images and depression suggests that negative visual mental imagery is not only present in depression but may also be more impairing than verbal thought. Researchers have consistently found that visual mental images are experienced as more realistic and similar to real perception, more emotionally arousing, and more preoccupying compared with verbal thoughts (e.g., Hales et al.

2011; Hyman and Pentland 1996; Mathews et al. 2013). This suggests that a visual form of depressive cognition may be more impairing than depressive cognition in verbal form.

Visual Mental Imagery More Realistic than Verbal Thought

First, visual mental images are found to be more realistic and similar to real perception compared to verbal thoughts. Across two studies, Holmes et al. (2008) instructed participants to mentally combine a picture with a related word caption and to rate the extent to which their mental combination reflected a real autobiographical memory. Participants who combined the stimuli using mental imagery rated their combination as being more similar to a real memory compared with those who used verbal thought, suggesting that mental imagery may be perceived as more realistic than verbal thought.

Additional studies have shown visualization to be more strongly linked to false memory encoding than verbalization. Hyman and Pentland (1996) instructed participants to think about a false childhood event. Half of participants were told to imagine the event while half were only told to think about it. When asked about the event 2 days later, those individuals who were instructed to visually imagine the false event were more likely to confuse the event as real compared to those that were only told to think about the event.

Mathews et al. (2013) presented participants with words that varied in whether or not they were shown with a corresponding picture. Participant instructions were also manipulated such that in response to the items, participants were either instructed to generate their own visual mental image or to construct a descriptive verbal sentence in their head. A day later, participants were presented with the previously seen words and were told to indicate whether the word had previously been shown with a corresponding picture. Across three studies, Mathews et al. found that participants were more likely to confuse their own visual mental images with the actual presentation of a picture compared to when they constructed a descriptive verbal sentence.

Lastly, mental imagery appears to share underlying neural mechanisms with actual perception (see Heyes et al. 2013; Kosslyn et al. 2001). Brain imaging reveals substantial overlap in brain activation during visual mental imagery and perception. Ganis et al. (2004), for example, assigned participants to either view pictures of objects (perception) or mentally imagine the same objects (mental imagery) while scanned with functional magnetic resonance imaging (fMRI). Researchers found a 92% overlap in brain activation across the two conditions. O'Craven and Kanwisher (2000) found similar overlap in activation, on average 92% for viewing versus mentally imagining places and 84% for viewing versus mentally imagining faces. Although comparisons

were not made with verbal thought, the fact that visual mental imagery shares such high overlap in activation with perception suggests that compared to verbal thought, visual mental imagery may be experienced as more similar to actual perceptual experience.

Visual Mental Imagery More Emotionally Salient than Verbal Thought

Along with being more realistic than verbal thought, visual mental imagery is consistently shown to be more emotionally arousing. In the previously described study, Mathews et al. (2013) also varied the valence of the word captions presented (negative, benign). After each trial, participants rated how pleasant their visual mental image or constructed verbal sentence was. In line with hypotheses, Mathews et al. found that negative items were rated as more unpleasant when they were visually imagined compared to when participants constructed a descriptive verbal sentence.

Additional evidence for the emotional salience of visual mental imagery comes from the cognitive bias modification literature. When participants were exposed to ambiguous scenarios (e.g., *You are starting a new job that you very much want. You think about what it will be like and feel...*) that were resolved either negatively (e.g., *concerned*) or positively (e.g., *extremely optimistic*), they consistently rated the negatively resolved scenarios as more negative when instructed to use visual mental imagery compared to when they were instructed to process the scenarios verbally (Holmes et al. 2006, 2009b; Holmes and Mathews 2005).

Visual mental imagery not only appears to magnify negative affect but positive affect as well. In Mathews et al. (2013), benign items were rated as more pleasant when they were imagined as visual mental images compared to when they were described as verbal sentences, and in the series of studies by Holmes and colleagues, positively resolved scenarios were rated as more positive when processed in the form of visual mental images compared to in verbal form (Holmes et al. 2006, 2009b; Holmes and Mathews 2005). Additional research also found that retrieving positive memories using visual mental imagery led to greater mood improvement compared to when verbal focused processing was used (Nelis et al. 2015; Werner-Seidler and Moulds 2012). This body of work suggests that visual mental imagery is not simply more negative than verbal thought; rather, visual mental imagery may act as an emotion amplifier (Holmes et al. 2009a).

Visual Mental Imagery More Preoccupying than Verbal Thought

Importantly, rumination is not simply the experience of negative cognitions but rather entrenchment in cycles of

perseverative thinking about these cognitions. Initial evidence suggests that individuals may be more preoccupied with past-oriented visual mental images compared to verbal thoughts (e.g., Hales et al. 2011). Hales et al. compared visual suicidal imagery and verbal suicidal thoughts in populations with bipolar disorder or unipolar depression. Using the Suicidal Cognitions and Flashforwards Interview (Holmes et al. 2007), clinicians asked participants about the content and qualities of their verbal thoughts and visual mental images related to suicide. Participants were told to remember the time they felt most suicidal and asked whether they experienced suicide-related visual mental images and/or suicide-related verbal thoughts. Next, participants rated these cognitions for how much time they spent preoccupied with this visual mental imagery or verbal thought and how compelling the visual mental image or verbal thought was. Hales et al. found that although visual mental imagery and verbal thoughts were similarly compelling, suicidal participants reported significantly greater preoccupation with suicidal visual mental images compared with suicidal verbal thoughts. The finding that suicidal ideation in the form of visual mental images results in greater preoccupation than suicidal ideation in the form of verbal thoughts may suggest that past-oriented depressive visual mental images could be more susceptible to the perseveration characteristic of rumination than depressive verbal thoughts. Again, this may be in contrast to future-oriented worry, which appears to be predominately verbal (e.g., Borkovec et al. 1998).

Gender Differences

In adulthood, women are at twice the risk for depression as men (Nolen-Hoeksema 1987, 1990; Weissman and Klerman 1977). This finding is well-replicated and holds both for subclinical depressive symptoms and full diagnosable MDD. Women also ruminate to a greater extent than men (Butler and Nolen-Hoeksema 1994; Nolen-Hoeksema et al. 1993), and it appears that individuals who ruminate are not only at increased risk for depression, but also that gender differences in rumination at least partially account for gender differences in depression (e.g., Johnson and Whisman 2013). Thus, women's greater tendency to ruminate in response to stress appears to contribute to their greater risk for depression.

Given well-established findings that females ruminate to a greater extent than males (e.g., Nolen-Hoeksema et al. 1993) and that gender moderates the relationship between rumination and severity of depression, with stronger associations for females than males (e.g., Nolen-Hoeksema 2001), it will be important to consider whether females and males tend to experience depressive cognitions in different forms (visual versus verbal) and whether they are differentially

impacted by the experience of rumination based on this tendency. Gender differences in response to visual mental imagery (e.g., Lang et al. 1993) suggest that women may be especially negatively affected by rumination when they tend to experience depressive cognition as visual. There is some evidence that women have greater visual mental imagery abilities than men (e.g., Kosslyn et al. 1990), that women rate visual mental images as more vivid than males (Richardson 1995), and that women respond to emotionally arousing visual stimuli with greater physiological response than men (Lang et al. 1993). Although these gender differences are not consistently found in mental imagery ability or response to visual mental images, when they are found, such differences tend to favor women using and responding to visual mental imagery more so than men. Thus, one would expect that the relationship between rumination and depression would be stronger for women than for men, especially when they experience visual depressive cognitions as compared to verbal depressive cognitions.

Present Studies

Despite research finding that visual mental images and verbal thoughts are experienced differently in terms of realism, emotionality, and susceptibility to preoccupation, researchers have only recently begun to examine visual mental imagery in clinical domains such as depression. What research does exist suggests that visual mental imagery is common in depression (Moritz et al. 2014; Patel et al. 2007), that the experience of visual mental imagery may exacerbate depressive symptoms (Moritz et al. 2014), and that rumination in particular can be non-verbal and sensory-rich (e.g., McLaughlin et al. 2007; Pearson et al. 2008; Watkins et al. 2005). Further research documenting rates of visual and verbal styles of rumination and comparing how visual and verbal rumination may differentially impact depression is crucially needed, however. For clinicians to intervene effectively with clients who ruminate, matching treatment strategies based on how client experience their depressive cognitions (visually, verbally), may be beneficial. The present series of studies examined rates of visual and verbal styles of depressive cognition and explored how the relationship between rumination and depressive symptom severity differed based on whether individuals think about their depressed affect visually or verbally.

Study 1

Study 1 aimed to (1) document the prevalence of visual and verbal styles of depressive cognition and (2) examine whether the relationship between rumination and depressive symptoms differed based on whether individuals

experienced depressive cognition predominately visually or predominately verbally. In line with previous research (e.g., Watkins et al. 2005) we expected that only approximately half of participants would report that their depressive cognitions tend to be in verbal form, despite the field's focus on depressive cognitions as verbal. We also hypothesized that the relationship between rumination and depressive symptoms would be stronger for individuals who reported a visual style of depressive cognition compared with a verbal style of depressive cognition. Given findings that visual cognition is more realistic and emotionally arousing than verbal cognition (e.g., Holmes and Mathews 2010; Mathews et al. 2013), we expected that greater rumination would be associated with more severe depressive symptoms when individuals tend to experience their depressive cognitions as visual compared to verbal. If found, interventions for rumination could potentially be tailored based on whether individuals tend to have visual or verbal depressive cognitions. To test our predictions, participants reported the degree to which they engaged in rumination, whether their depressive cognitions tend to be predominately visual or verbal (i.e., depressive cognitive style), and the severity of their depressive symptoms. Depressive cognitive style (visual, verbal) was then tested as a moderator of the relationship between rumination and depressive symptoms.

Method

Participants University student participants ($N=220$; 53.4% female) ranged in age from 18 to 29 ($M_{age}=19.03$, $SD=1.34$). Participants were invited to complete a laboratory-based assessment in exchange for course credit. Participants provided informed consent, demographic information, and completed self-report assessments of rumination, depressive cognitive style (visual, verbal), and depressive symptoms. This study was part of a larger laboratory session that also included a computer-based recognition task and additional self-report measures of emotional adjustment and social relationships.

The proportion of missing data in the present study ranged from 0.9% (depressive symptoms) to 1.4% (degree of rumination). Data were missing completely at random [Little's test: $\chi^2(2, N=219)=1.37$, $p=0.50$]; thus, missing data were imputed using expectation maximization in SPSS. Participants ($n=8$) who did not respond to the question regarding their depressive cognitive style (visual, verbal) were excluded from analyses, resulting in a final sample size of 212.

Demographics and Basic Information Items assessed participants' date of birth, gender, race, and ethnicity.

Rumination Participants rated the 22 items of the Ruminative Responses Scale (RRS; Nolen-Hoeksema and Morrow 1991). This self-report measure assesses the degree to which individuals ruminate (i.e., dwell on negative affect) when they feel down, sad, or depressed (e.g., "think about how alone you feel"; "think about how sad you feel"; "think about how angry you are with yourself"). Participants indicated how often they experienced each thought from 1 (*almost never*) to 4 (*almost always*). Individual items were summed to provide a total score such that higher total scores reflected greater rumination. This measure provided a reliable measure of rumination in the present study ($\alpha=0.96$).

Depressive Cognitive Style To assess visual/verbal depressive cognitive style, participants completed an adapted version of the Sensory Properties of Depressive Thoughts Questionnaire (SPD; Moritz et al. 2014), which asks about all sensory properties of depressive thoughts (visual, auditory, tactile, somatic, olfactory, and other). The SPD was altered to focus on visual and verbal content of depressive cognitions given that these two properties were found to be most common in previous studies (e.g., Moritz et al. 2014). Immediately following the completion of the RRS, participants were told, "When people are depressed, their depressed thoughts can seem like words or images," and asked, "When you have depressed thoughts, do they tend to be more in words or more in images?" Participants then responded to a single categorical item that asked whether they experienced their depressed cognitions either predominately in the form of words or predominately in the form of mental images.

Depressive Symptoms Participants rated each of the 20 items of the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff 1977) to assess how often within the last week they experienced various affective, somatic, interpersonal, cognitive, and behavioral symptoms of depression (e.g., "I thought my life had been a failure."; "I felt lonely"; "I felt that people dislike me"). Items are rated on a scale from 0 [*Rarely or none of the time (less than 1 day)*] to 3 [*Most or all of the time (5–7 days)*]. Individual items were reverse coded as appropriate and summed to provide a total score such that higher total scores reflected more severe depressive symptoms. As with previous studies, the CES-D was found to be a reliable measure of depressive symptoms in the present study ($\alpha=0.92$).

Results

Characteristics of Individuals Who Experience Depressive Cognitions as Visual or Verbal First, the prevalence of visual and verbal styles of depressive cognition was explored. 42.9% of the sample reported that their depressive cognitions

Table 1 Study 1 means and standard deviations by depressive cognitive style

	Visual			Verbal		
	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range
Rumination	38.10	12.80	22–75	40.21	14.01	22–80
Depressive symptoms	11.95	9.51	0–44	13.48	10.52	0–46

Individuals with visual and verbal depressive cognitive styles did not significantly differ on degree of rumination or severity of depressive symptoms

Table 2 Study 1 correlations among primary constructs

	1	2	3
1. Rumination			
2. Depressive cognitive style (visual, verbal)	–0.078		
3. Depressive symptom severity	0.73*	–0.075	

* $p < 0.001$

were predominately in the form of visual mental images and 57.1% reported that their depressive cognitions were predominately in the form of words. It is therefore clear that a substantial proportion of individuals do, in fact, experience their depressive cognitions visually. There was not a significant association between depressive cognitive style (visual, verbal) and gender, $\chi^2(1) = 0.80, p = 0.37; \phi = 0.06$. Individuals who experienced depressive cognitions as predominately visual or verbal also did not differ in degree of rumination [$t(211) = 1.13, p = 0.26; d = 0.16$] or severity of depressive symptoms [$t(211) = 1.10, p = 0.27; d = 0.15$] (see Table 1 for means and standard deviations by depressive cognitive style).

Does Depressive Cognitive Style (Visual, Verbal) Moderate the Relationship Between Rumination and Depressive Symptom Severity? As expected based on prior literature, degree of rumination was significantly correlated with severity of depressive symptoms, with greater rumination associated with more severe depressive symptoms ($r = .73, p < 0.001$; see Table 2). Moderated regression analyses were then conducted to test whether the relationship between rumination and depressive symptoms differed based on depressive cognitive style (visual, verbal). On step 1, main effects of rumination (centered at the grand mean) and depressive cognitive style (dummy coded: 0 = verbal depressive cognition, 1 = visual depressive cognition) were entered. On step 2, the interaction between rumination and depressive cognitive style was entered. Depressive cognitive style (visual, verbal) did not significantly moderate the relationship between rumination and depression as there was a negligible increase in variance explained on step 2, $\Delta R^2 < 0.005, F(1, 208) = 0.034, p = 0.86$. The strength of the association between rumination and depressive symp-

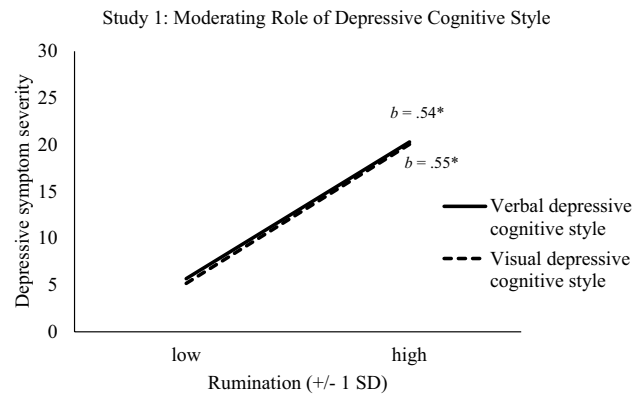


Fig. 1 Depressive cognitive style (visual, verbal) did not moderate relationship between rumination and severity of depressive symptoms. Equally strong relationship between rumination and depressive symptom severity for individuals who experienced depressive cognition as visual and verbal. * $p < 0.001$

toms was equally strong for individuals who tend to experience depressive cognition as visual ($b = 0.55, p < 0.001$) and verbal ($b = 0.54, p < 0.001$) (see Fig. 1). Thus, rumination appears to be strongly related to depressive symptom severity regardless of whether individuals have predominately visual or verbal depressive cognitive styles.

Does Depressive Cognitive Style (Visual, Verbal) Function Differently as a Moderator of the Relationship Between Rumination and Depressive Symptoms for Males and Females? Given well-evidenced gender differences in rumination and depression, gender was subsequently added to the model to examine whether the moderating role of depressive cognitive style differed for males and females. On step 1, main effects of rumination (centered at the grand mean), depressive cognitive style (dummy coded: 0 = verbal depressive cognition, 1 = visual depressive cognition), and gender (dummy coded: 0 = female, 1 = male) were entered. On step 2, two-way interactions (rumination \times depressive cognitive style; rumination \times gender; depressive cognitive style \times gender) were entered. On step 3, the three-way interaction between rumination, depressive cognitive style, and gender was entered. There was a negligible increase in variance explained on step 3, $\Delta R^2 < 0.005, F(1, 203) = 0.066, p = 0.80$, indicating that the three-way interaction with

gender was not significant and that rumination style does not function differently as a moderator between rumination and depressive symptom severity for males and females. It appears instead that rumination is similarly related to severity of depressive symptoms regardless of whether individuals experience visual or verbal depressive cognitions for both males and females.¹

Discussion

Study 1 demonstrated the incidence of predominately visual and verbal styles of depressive cognition. Building on prior research suggesting that depressive cognition can be multi-sensory, a large proportion of individuals did in fact report that they tend to experience depressive cognition visually. Individuals with a visual depressive cognitive style ruminated as much as individuals with a verbal depressive cognitive style, experienced similar levels of depressive symptoms as individuals with a verbal depressive cognitive style, and males and females were equally likely to have a visual or verbal depressive cognitive style. Rumination was associated with similarly severe depressive symptoms when individuals reported experiencing predominately visual depressive cognitions compared with predominately verbal depressive cognitions, for both males and females.

Study 2

Study 2 replicated and extended Study 1. Along with assessing for visual or verbal styles of depressive cognition, individuals could also indicate that they experience depressive cognition as both visual and verbal. At times, individuals may experience their depressive cognitions as both visual and verbal, or as alternating between visual and verbal. In Moritz et al.'s (2014) survey of depressed adults' sensory properties of depressive cognitions, 62% of participants who did experience sensory-rich depressive cognitions experienced those thoughts across multiple sensory channels (i.e., more than one sensory modality). Williams and Moulds (2007) also found that intrusive memories common to depression are often experienced as having both visual and auditory qualities. Averaged across assessments of intrusive memories, 20.6% of this sample experienced these memories both visually and verbally.

In addition to it being possible that individuals experience depressive cognitions as both visual and verbal, rumination

may be more strongly linked to depressive symptom severity when individuals tend to experience depressive cognition in both forms. Individuals who are especially susceptible to rumination may ruminate on depressive cognitions in all forms available to them (both visual and verbal), leading to greater increases in depressive symptoms than individuals who experience depressive cognition in a single form (visual or verbal only). Thus, we hypothesized that some individuals would report that they experience depressive cognition as both visual and verbal and that if differences were found between depressive cognitive styles, that there would be a stronger relationship between rumination and depressive symptoms for individuals who report both visual and verbal depressive cognition compared with only visual or only verbal depressive cognition.

Method

Participants and Procedure Similar to Study 1, in Study 2, University students ($N=127$; $M_{age}=19.16$, $SD=2.98$; age range 17–48; 56.7% female) received credit toward an introductory psychology course for their participation. The Study 2 procedure was identical to the Study 1 procedure apart from the study being conducted in online survey format and the addition of a “both visual and verbal” answer option to the measure of depressive cognitive style.

The proportion of missing data ranged between 0.80% (depressive cognitive style) to 8.70% (degree of rumination, age). Data were missing completely at random [Little's test: $\chi^2(5, N=116)=9.93$, $p=0.08$];² thus, missing data were again imputed using expectation maximization in SPSS. One participant did not respond to the question asking about depressive cognitive style (visual, verbal, both) and was excluded from analysis resulting in a final sample size of 126.

Demographics and Basic Information Participants completed the same demographics questionnaire assessing date of birth, gender, race, and ethnicity.

Rumination As with Study 1, rumination was assessed with the RRS ($\alpha=0.94$).

Depressive Cognitive Style Again, following the completion of the RRS, participants were told, “When people are

¹ Given evidence that there may be brooding and reflection subtypes of rumination (e.g., Burwell and Shirk 2007), all analyses were re-run using only the brooding or reflection subscales of the RRS. As patterns of findings using the rumination total score, brooding subscale score, and/or reflection subscale score were identical, only the results for the rumination total score are presented.

² Given that Little's test was marginally significant, follow-up analyses were conducted to compare participants who were missing at least one item with participants with complete data. On the RRS, participants who had missing data did not differ from participants who did not have missing data, $t(124)=0.46$, $p=0.96$; $d=0.26$. On the CES-D, participants who had missing data also did not differ from participants who did not have missing data, $t(125)=0.33$, $p=0.74$; $d=0.13$.

Table 3 Study 2 means and standard deviations by depressive cognitive style

	Visual			Verbal			Both		
	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range	<i>M</i>	<i>SD</i>	Range
Rumination	36.22	10.66	22–62	38.11	12.17	22–75	41.10	13.65	22–78
Depressive symptoms	11.80	8.57	0–34	13.04	8.67	1–38	16.51	12.10	1–51

Individuals with visual, verbal, and both visual and verbal depressive cognitive styles did not significantly differ in degree of rumination or severity of depressive symptoms

depressed, their depressed thoughts can seem like words or images.” In Study 2 they were then asked, “When you have depressed thoughts, do they tend to be more in words, more in images, or in both?” Participants then responded to a single item that asked whether they tend to experience depressive cognition in the form of words, in images, or in both words and images.

Depressive Symptoms As with Study 1, severity of depressive symptoms was assessed with the CES-D ($\alpha = 0.92$).

Results

Characteristics of Individuals Who Experience Depressive Cognitions as Visual, Verbal, or Both Visual and Verbal First, the prevalence of visual, verbal, and both visual and verbal styles of depressive cognition was examined. In line with Study 1, visual depressive cognition was common. Out of the total sample, 23.8% reported an only-visual depressive cognitive style, 38.9% an only-verbal depressive cognitive style, and 37.3% a both visual and verbal depressive cognitive style. Taken together, 61.1% of the sample reported some kind of visual depressive cognition (either in isolation or in combination with verbal depressive cognition), again confirming that a substantial proportion of individuals do in fact experience depressive cognition in visual form. As in Study 1, males and females did not differ in their likelihood of reporting visual, verbal, or both depressive cognitive styles, $\chi^2(4) = 2.15$ $p = 0.71$; $\phi = 0.13$, and there was not a significant effect of depressive cognitive style (visual, verbal, both) on degree of rumination [$F(2, 123) = 1.53$, $p = 0.22$; $\eta^2 = 0.02$] or severity of depressive symptoms [$F(2, 123) = 2.39$, $p = 0.096$; $\eta^2 = 0.04$] (see Table 3 for means and standard deviations by depressive cognitive style). Although not statistically significant, an effect size of 0.04 does suggest that there may be differences in depressive symptom severity based on depressive cognitive style. Individuals who reported experiencing depressive cognition both visually and verbally had higher levels of depressive symptoms ($M = 16.51$) than individuals who reported experiencing depressive cognition only verbally ($M = 13.04$) or only visually ($M = 11.80$). Further replication is needed to clarify whether depressive symptom severity consistently varies based on depressive cognitive style.

Table 4 Study 2 correlations among primary constructs

	1	2	3
1. Rumination			
2. Depressive cognitive style (visual, verbal, both)	0.10		
3. Depressive symptom severity	0.73*	0.15	

* $p < 0.001$

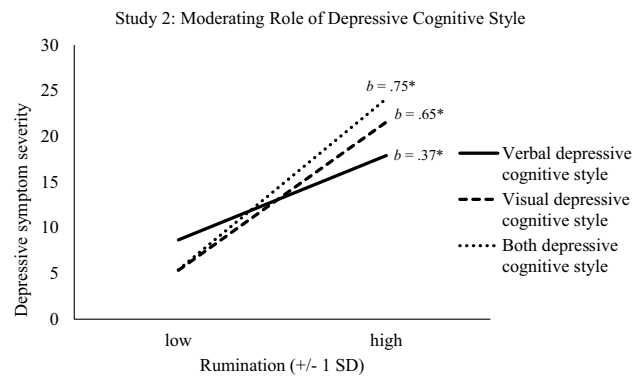


Fig. 2 Depressive cognitive style (visual, verbal, both) significantly moderated the relationship between rumination and severity of depressive symptoms, with a stronger relationship between the constructs when individuals reported experiencing depressive cognition only visually, or both visually and verbally, compared with only verbally. * $p < 0.001$

Does Depressive Cognitive Style (Visual, Verbal, Both) Moderate the Relationship Between Rumination and Depressive Symptom Severity? Again, rumination was significantly and positively correlated with severity of depressive symptoms ($r = .73$, $p < 0.001$; see Table 4). To test the moderating role of depressive cognitive style, main effects of rumination (centered at the grand mean) and depressive cognitive style ([0 0]=verbal depressive cognition, [1 0]=visual depressive cognition, [1 1]=both; represented by two dummy codes) were entered on step 1, and two-way interactions were entered on step 2. The relationship between rumination and depressive symptoms significantly differed based on depressive cognitive style (visual, verbal, both; see Fig. 2), as evidenced

Study 2: Gender Differences in Moderating Role of Depressive Cognitive Style

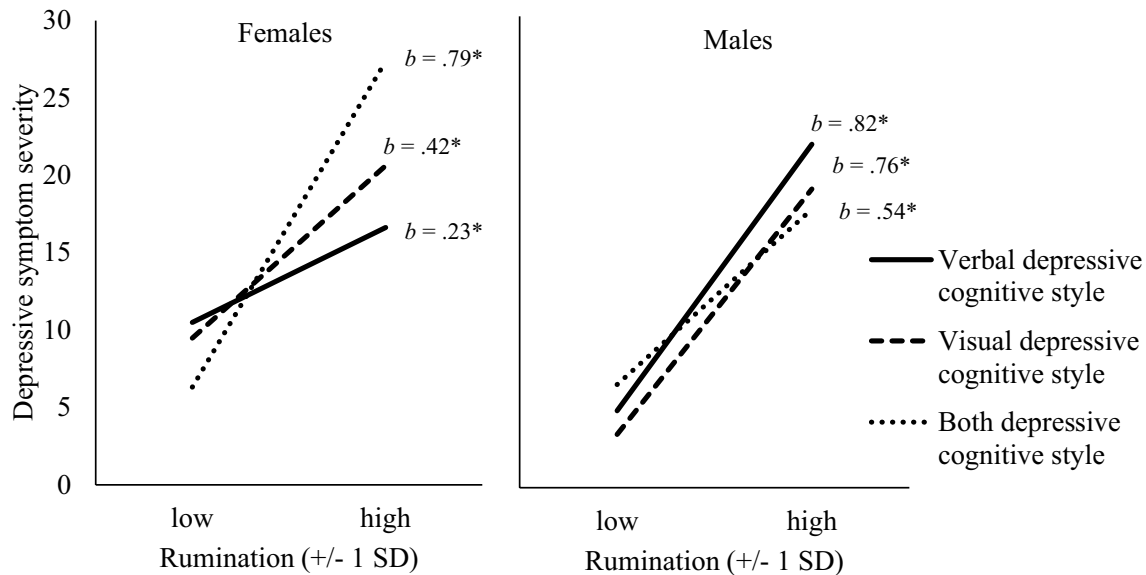


Fig. 3 For females, depressive cognitive style (visual, verbal, both) significantly moderated the relationship between rumination and severity of depressive symptoms, with a stronger relationship between the constructs when individuals reported experiencing

depressive cognition both visually and verbally, compared with only verbally. For males, depressive cognitive style (visual, verbal, both) did not significantly moderate the relationship between rumination and severity of depressive symptoms. $*p \leq 0.05$

by a significant but small increase in variance explained on step 2, $\Delta R^2 = 0.043$, $F(2, 120) = 6.28$, $p = 0.003$ (see Fig. 2).

There was a significant relationship between rumination and depressive symptoms for individuals who tend to experience depressive cognitions visually ($b = 0.65$, $p < 0.001$), verbally ($b = 0.37$, $p < 0.001$), and both visually and verbally ($b = 0.75$, $p < 0.001$). The relationship between rumination and depressive symptoms was significantly stronger for individuals who experienced depressive cognition only visually compared to only verbally ($b = 0.28$, $p = 0.049$, 95% CI [0.001–0.56], $SE = 0.14$) and for individuals who experienced depressive cognition both visually and verbally compared to those who experienced depressive cognition only verbally ($b = 0.37$, $p = 0.001$, 95% CI [0.16–0.59], $SE = 0.11$), but not only visually ($b = 0.09$, $p = 0.49$, 95% CI [–0.18 to 0.36], $SE = 0.14$). Rumination was more highly related to depressive symptoms when individuals experienced depressive cognition both visually and verbally compared with only verbally, but not only visually; thus, rumination via visual depressive cognition may be associated with increased depressive symptoms over and above rumination via verbal depressive cognition. Of note, however, effect sizes were small, suggesting that as in Study 1, rumination is certainly maladaptive regardless of whether depressive cognitions are visual, verbal, or both visual and verbal.

Does Depressive Cognitive Style Function Differently as a Moderator of the Relationship Between Rumination and Depressive Symptoms for Males and Females? As in Study 1, gender was subsequently added to the model to examine whether the moderating role of depressive cognitive style differed for males and females. On step 1, main effects of rumination (centered at the grand mean), depressive cognitive style ([0 0] = verbal depressive cognition, [1 0] = visual depressive cognition, [1 1] = both; represented by two dummy codes), and gender (dummy coded: 0 = female, 1 = male) were entered. On step 2, two-way interactions were entered and on step 3, three-way interactions were entered. There was small increase in variance explained on step 3, $\Delta R^2 = 0.029$, $F(2, 114) = 4.55$, $p = 0.013$, indicating that the three-way interaction with gender was significant and that depressive cognitive style may function differently as a moderator for males and females. In particular, the three-way interaction between rumination, depressive symptom severity, and the dummy code representing the comparison between individuals who experienced their depressive cognitions only verbally or both verbally and visually was statistically significant, $b = -0.66$, $p = 0.003$, 95% CI [–1.10 to –0.23], $SE = 0.22$.

For both females and males, the relationship between rumination and depressive symptom severity was significant and positive for visual, verbal, and both visual and verbal depressive cognitive styles (see Fig. 3a, b). Thus, follow-up analyses were conducted to determine how depressive

cognitive style functioned differently for females and males. First, the data were split by gender such that the moderating role of depressive cognitive style could be evaluated for females and males separately. Next, moderated regression analyses were conducted with the female-only and male-only datasets. With depressive symptom severity as the dependent variable, main effects of rumination (centered at the grand mean) and depressive cognitive style ([0 0] = verbal depressive cognition, [1 0] = visual depressive cognition, [1 1] = both; represented by two dummy codes) were entered on step 1 and the interactions between rumination and depressive cognitive style were entered on step 2.

For females, depressive cognitive style (visual, verbal, both) significantly moderated the relationship between degree of rumination and severity of depressive symptoms (see Fig. 3) as evidenced by a significant increase in variance explained on step 2, $\Delta R^2 = 0.11$, $F(2, 65) = 9.11$, $p < 0.001$. There was a stronger relationship between rumination and depressive symptom severity for those females who experienced their depressive cognitions both visually and verbally compared with only verbally, $b = 0.56$, $p < 0.001$, 95% CI [0.30–0.82], $SE = 0.13$. This indicates that for women, engaging in rumination when they tend to have both visual and verbal depressive cognitions is associated more strongly with depressive symptom severity compared with when they tend to have only verbal depressive cognitions. There was not a significant difference between females who experienced depressive cognition only verbally compared with only visually ($b = 1.29$, $p = 0.51$, 95% CI [–2.95 to 5.94], $SE = 2.23$) or between females who experienced depressive cognition only visually compared with both visually and verbally ($b = 0.37$, $p = 0.11$, 95% CI [–0.086–0.82], $SE = 0.23$). Thus, for females, it does appear that greater rumination is associated with greater depressive symptom severity when they tend to experience depressive cognition as both visual and verbal compared with only verbally.

For males, however, depressive cognitive style did not moderate the relationship between rumination and depressive symptom severity (see Fig. 3). There was a negligible increase in variance explained on step 2, $\Delta R^2 = 0.018$, $F(2, 47) = 1.20$, $p = 0.31$. Thus, although there was a significant and positive association between rumination and depressive symptom severity for visual ($b = 0.76$, $p < 0.001$), verbal ($b = 0.82$, $p < 0.001$), and both ($b = 0.54$, $p < 0.001$) styles of depressive cognition, the rumination–depression relationship did not vary in strength based on the style with which males tend to experience their depressive cognitions (visual, verbal, both).³

³ As in Study 1, all analyses were repeated with the brooding and reflection subscales of the RRS. All patterns of findings were analogous using the rumination total score, brooding subscale score, and reflection subscale score; thus, results using the rumination total score are presented.

Discussion

Study 2 largely replicated Study 1, providing additional evidence that many individuals do in fact experience depressive cognition in visual form whether it be only visual or both visually and verbally. In fact, the majority of participants reported some visual depressive cognition. Rumination was significantly and similarly related to depressive symptoms whether participants reported having visual, verbal, or both visual and verbal styles of depressive cognition.

The strength of the relationship between rumination and severity of depressive symptoms did differ slightly based on depressive cognitive style. In the overall sample, increases in rumination were more strongly related to increases in depressive symptoms for individuals who had only visual or both visual and verbal depressive cognition, compared with those individuals who experienced depressive cognition only verbally. It may be that rumination is more strongly related to depressive symptoms when individuals experience their depressive cognition as visual (both in isolation and in combination with verbal depressive cognition) compared to verbal alone. Again, however, effects were small suggesting that ruminating, whether it be via visual, verbal, or both visual and verbal depressive cognitions, is impairing.

When gender differences were examined, differences between females and males were found in terms of the relationship between rumination and depressive symptoms based on depressive cognitive style. For females, increases in rumination were associated with greater increases in depressive symptom severity when they experienced depressive cognition as both visual and verbal compared with only verbally. For males, however, increases in rumination were associated with similar increases in depressive symptom severity whether they had visual, verbal, or both visual and verbal depressive cognitive styles. Again, for both males and females, rumination was associated with increased depressive symptoms regardless of depressive cognitive style. For females specifically, greater engagement in rumination may be associated with greater depressive symptom severity when they have both visual and verbal depressive cognition compared to only verbal depressive cognition.

Overall Conclusions

Based on findings across both studies and in line with previous work (e.g., Moritz et al. 2014; Patel et al. 2007; Watkins et al. 2005; Williams and Moulds 2007), it is clear that a large proportion of individuals do in fact experience depressive cognition in visual form. In Study 1, 42.9% of participants reported having a visual depressive cognitive style and in Study 2, 61.1% of participants reported that they experienced depressive cognition either only visually

or both visually and verbally. Individuals with visual and verbal depressive cognitive styles did not differ in the mean amount they ruminated or their mean level of depressive symptoms in either study.

Rumination was positively associated with depressive symptom severity whether individuals had visual, verbal, or both visual and verbal depressive cognitive styles. These findings are in line the idea that rumination falls under the umbrella of RNT (e.g., Ehring and Watkins 2008). RNT is thought to be a transdiagnostic process in which thinking over and over again about maladaptive and negative cognitions results in distress, regardless of the exact content or form of negative cognitions.

If at its core, rumination is the repeated rehearsal of negatively valence cognitions, one would expect, however, that rehearsing more realistic (e.g., Hyman and Pentland 1996) and emotionally charged (e.g., Mathews et al. 2013) visual depressive cognitions would be associated with greater severity of depressive symptoms compared with rehearsal of less realistic or emotionally charged verbal depressive cognitions. This idea was partially supported. In Study 2, rumination was particularly highly associated with depressive symptoms when individuals reported experiencing visual depressive cognitions, especially for women. When individuals who experienced depressive cognition both visually and verbally were taken into account, there was a statistically stronger relationship between rumination and depressive symptoms for individuals who reported an only visual, or both visual and verbal depressive cognitive style, compared with individuals who reported an only verbal depressive cognitive style, though effects were small. Gender differences also emerged in Study 2. For women only, rumination was associated with greater depressive symptom severity when they experienced depressive cognition in both visual and verbal form compared to when they experienced depressive cognition in only verbal form. For males on the other hand, increases in rumination were similarly associated with depressive symptom severity for all depressive cognitive styles (visual, verbal, both).

The finding that there was a stronger relationship between rumination and depressive symptoms for women who experienced both visual and verbal depressive cognitions compared with only verbal depressive cognitions may suggest that visual forms of rumination are especially impairing for women. As noted, there is some evidence that women have greater mental imagery abilities than men (Lang et al. 1993). Thus, for women, ruminating in the form of visual depressive cognitions may mean repeatedly replaying vivid and realistic negative mental images whereas for men, visual depressive cognitions may not be as emotionally intense. Alternatively, it is also possible that rumination in both visual and verbal form increases cognitive load, or the amount of mental energy required to sustain the ruminative process.

Ruminating both visually and verbally would therefore deplete working memory resources that could be allocated to more adaptive responses such as distraction or problem solving. That said, there is little evidence as to why females would be exclusively impacted by this greater cognitive load.

Further research is needed on gender differences in response to rumination via visual depressive cognition. In particular, work focused on how vivid and realistic visual depressive cognition is for males and females and how males and females may be differentially impacted by the cognitive load associated with dwelling on visual and verbal depressive cognition. Gender differences related to visual/verbal styles of depressive cognition may play a small, but perhaps relevant, part of a larger and more complex picture contributing to why rumination may be especially impairing for women, though the correlational nature of these studies limit conclusions drawn regarding the causality of these effects.

Limitations and Future Directions

Although the present series of studies contributes to our understanding of rumination, and in particular rumination when individuals tend to experience their depressive cognition as visual, there are limitations to this work that warrant further examination in future studies. First, the assumption was made that if individuals tend to experience their depressive cognitions as visual, verbal, or both visual and verbal, that they also tend to dwell on, or ruminate about, their depressive cognitions in the same form. It is certainly possible that visual or verbal depressive cognitions are more or less susceptible to the perseveration characteristic of rumination and that rumination takes a different form than one typically experiences their depressive cognition as. Further research specifically asking participants about the visual and verbal qualities of their ruminative cognitions is needed to expand on this work.

Additionally, these studies relied exclusively on self-reports of depressive cognitive style. Although depressive cognition is an internal process that may require some degree of subjective report, findings from the present study could be bolstered by experimental induction of rumination on visual or verbal depressive cognition to determine how the experience of rumination via visual mental imagery versus verbal thought may differ in the moment they occur. At the very least, it may be beneficial to ask participants to report their depressive cognitive style while they are ruminating rather than relying on retrospective report of how they generally experience their depressive cognitions.

Study 2 also demonstrated that many individuals experience their depressive cognitions both visually and verbally. Using a categorical measure of depressive cognitive style (visual, verbal, both) may therefore not best capture the true nature of how individuals experience their

depressive cognition. Instead, individuals may engage in more or less visual depressive cognition and more or less verbal depressive cognition, rather than falling in categories of visual or verbal or along a single continuum from visual to verbal. Future work using continuous measures of visual and verbal depressive cognitive styles would therefore further clarify how greater amounts of visual content in ruminative thoughts impact the experience of depression. Additionally, given that depressive cognition is often multisensory, further examination of alternate sensory qualities of depressive cognition (e.g., auditory, olfactory) may be helpful.

Lastly, both studies described presently relied on a single time point to measure rumination, depressive cognitive style, and depressive symptoms. Although the results of the present studies were interpreted with one direction of causation in mind (rumination and visual/verbal depressive cognitive style impacting depressive symptom severity), it is certainly possible that experiencing depressive symptoms influences the degree to which one ruminates and the style one tends to experience their depressive cognitions. Given this plausible bidirectionality, experimental research is needed to clarify causation and direction of effects. Findings also may not be extended to infer how rumination via visual or verbal forms of depressive cognition may impact the progression of depressive symptoms over time. Longitudinal research, potentially with a clinical sample, is needed to clarify how engagement in rumination on visual or verbal depressive cognition may differentially predict prospective changes in depressive symptom severity.

Across two studies, visual depressive cognition was shown to be common and associated with increased strength of the rumination–depression association, especially for women who experienced their depressive cognition both visually and verbally. It could therefore be useful to examine the extent to which considering rumination in visual form might inform novel experimental designs. Additionally, there is potential utility in refining assessment and intervention tools to specifically target visual depressive cognition. For example, clinicians could ask clients whether they typically experience visual mental images or verbal thoughts when perseverating on their depressed mood, and then employ traditional cognitive restructuring or imagery rescripting matched to client response. Such practices have potential to improve outcomes for those individuals who tend to experience depressive cognition as visual mental images.

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Compliance with Ethical Standards

Conflict of Interest Hannah R. Lawrence, Emily A. P. Haigh, Greg J. Siegle, and Rebecca A. Schwartz-Mette declare that they have no conflict of interest.

Informed Consent All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Animal Rights This article does not contain any studies with animals performed by any of the authors.

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