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IMAGERY VIVIDNESS AND PERCEPTUAL CLARITY: AFFECTIVE VISUAL
PROCESSING IN RELATION TO DEPRESSION AND ANXIETY

BY

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Abstract

The influence of visual mental imagery on emotion processing is well-established, and its vividness has further been shown to vary by valence and diagnostic groups. While both depression and anxiety are associated with dysfunctions in affective processing of visual imagery and visual percepts separately, a direct comparison of internal and external visual processing has not yet been undertaken. Moreover, while individual differences in imagery vividness have been observed in isolated psychopathologies, the manner in which these differences manifest in comorbid depression and anxiety is uncertain. The current study examined features of internal and external affective visual processing in relation to depression, anxiety, and their comorbidity, through an emotion appraisal task. In separate experimental blocks, participants were presented with trials of affective pictures and imagery cues and were subsequently asked to rate the emotional valence and clarity/vividness of each stimulus. Ratings were compared to participants' scores on self-report measures of depression and anxiety. Further analyses assessed the utility of continuous (dimensional) versus categorical (multidimensional) models of psychopathology. Results revealed depression scores alone to be associated with reduced vividness ratings for positive (but not negative or neutral) imagery. Further, depression was related to more negative appraisals of valenced imagery but not pictures, and reduced clarity ratings for valenced pictures but not neutral pictures. Results also support the utility of dimensional models of psychopathology, with limited evidence to support strong categorization of psychopathological features. Findings are discussed in relation to attention and reward processing, as well as cognitive and neural resource engagement.

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Introduction

If asked to imagine an apple sitting in the palm of one's hand, many people would close their eyes and "see in the mind's eye" an apple in their hand, without the need for a physical stimulus for reference. This is mental imagery: the visual representation of objects, actions, scenes, and events in the brain and mind in the absence of a visual percept. The ability to generate mental imagery is integral for daily functioning as it supports processes such as remembering the past, planning for the future, and manipulating information (Albers et al., 2013; Conway, 2001; Milton et al., 2021). It has long been known that visual mental imagery ability varies across individuals; however, the manner in which this variability manifests systematically in various psychopathologies has been relatively unexplored. While links between visual imagery and emotional processing (Holmes, Mathews, et al., 2008; Holmes & Mathews, 2005; Skottnik & Linden, 2019) and psychopathology (Andrade et al., 2012; Breslau, 2009; Hackmann & Holmes, 2004) are well established, further evidence from studies of depression and anxiety suggests that variability in imagery ability may be mediated by multiple factors, dependent on the presenting disorder.

Imagery Vividness

The idea that imagery vividness may vary across individuals dates as far back as 1880, when Sir Francis Galton performed his "breakfast table" experiment. This study asked its participants to describe, in as much detail as possible, how their breakfast table appeared on the morning of the experiment. It was observed that some participants were exceptionally detailed and accurate in their descriptions, while others experienced significant difficulty in completing the task. The result of this study was the first documentation of individual variability in the subjective vividness of mental imagery (Galton, 1880).

Vividness of mental imagery, in its modern form, is described as the *clarity* of the imagined image – how “real” or life-like it appears in the mind – which exists on a spectrum. At one end of the spectrum sits an acute ability to conjure extremely vivid, near perception-like imagery, termed *hyperphantasia* (Zeman et al., 2020), while at the other end, there is a complete absence of mental imagery, termed *aphantasia* (Zeman et al., 2015). Some explanations for variation in imagery vividness have been proposed (Nanay, 2021; Pearson, 2019), but researchers have yet to reach a consensus. For instance, participants with aphantasia demonstrate intact spatial-manipulation imagery but not object-based imagery (Keogh & Pearson, 2018), suggesting that imagery vividness may dissociate between ventral (object) and dorsal (spatial/action) pathways (Pearson, 2019). In this view, vision remains unimpaired due to a distinction between the processing of external information (e.g., seeing an apple) and internal information (e.g., the mental representation of an apple). Alternatively, just as external visual information can be processed consciously or unconsciously (Koivisto et al., 2010), Nanay (2021) suggests that the same distinction may apply to internal visual information (i.e., imagery) as well, proposing that individuals with aphantasia may exhibit a deficit only in conscious imagery, but not unconscious imagery. However, both theories have been subjected to criticism surrounding contradictory evidence and use of case studies (see Blomkvist, 2023, for a review).

Typically, imagery vividness has been assessed via self-reports of individual experience (e.g., Blajenkova et al., 2006; Marks, 1973; Reisberg et al., 2003). Due to the subjectivity of self-reports, it was suggested that a complete lack of imagery may be explained simply by a lack of metacognition (i.e., an unawareness that the experience of imagery was indeed occurring; Zeman et al., 2010). However, this explanation for imagery extremes was quickly overshadowed

by the development of an objective measure of imagery vividness (Pearson, 2014), which helped demonstrate that individuals tend to be accurate in their evaluations of their own imagery.

To objectively measure imagery vividness, researchers leveraged binocular rivalry paradigms that alter perception by manipulating internal mental states (Bergmann et al., 2016; Carmel et al., 2010). Binocular rivalry refers to the phenomenon that when two different images are presented to either eye, only one of the images – the *dominant* image – is perceived by the participant (rather than both images being superimposed on one another; Blake & Logothetis, 2002). In binocular rivalry paradigms, the image that is perceived by participants can be manipulated through the use of priming techniques such that the dominant image is likely to be the image that had previously been primed (Blake & Logothetis, 2002). Interestingly, it has been demonstrated that a mental image can also function as a priming stimulus. In Bergmann and colleagues (2016), participants were instructed to imagine an image, rate its vividness, and were subsequently presented with real rivalry stimuli. Imagery strength was defined as the percentage of trials where the imagery stimulus resulted in perceived dominance in subsequent rivalry presentations. The results showed that the imagery stimulus significantly and reliably preceded its rivalry dominance to an extent greater than 50/50 chance. This suggests that imagined stimuli reliably produce priming effects that are comparable to real perceptual experiences. Moreover, this effect was significantly correlated with subjective vividness ratings for each trial, suggesting that, for the most part, individuals were accurate in rating the subjective vividness experience of their imagery. Indeed, that visual imagery exhibited priming effects in a visual perceptual task points to the potential for our internal world to alter our experience of the external world.

Imagery vs. Perception

An important consideration when conducting imagery research is the extent to which the neural mechanisms for internally and externally generated visual experiences overlap; that is, how much similarity exists between visual imagery and visual perception in the brain. Understanding similarities and distinctions is critical for interpreting findings; for instance, impairments in perception may parallel or inform deficits in imagery if shared neural systems are involved (Pearson, 2019), whereas distinctions may point to unique mechanisms underlying imagery (Lee et al., 2012). Further, since many therapeutic techniques rely on imagery to simulate real-world experiences (e.g., Kumari & Patil, 2023; Wolpe, 1958), their effectiveness may depend on the degree to which imagery engages brain networks involved in visual perception.

From phenomenological evidence, similarity is assumed as both perception and imagery give rise to similar subjective visual experiences; for example, perceiving and imagining an apple both lead to an experience of a round, red object with a stem and perhaps even a leaf (for a review, see Pearson & Westbrook, 2015). Early studies identified a degree of interference between visual imagery and perceptual processing (Baddeley & Andrade, 2000; Segal & Fusella, 1969). For instance, Segal and Fusella (1969) demonstrated that maintaining a mental image interfered with participants' ability to detect faint visual signals. The reverse effect was also observed, where the vividness of visual imagery was reduced due to concurrent engagement in a visuo-spatial task (Baddeley & Andrade, 2000). Such mutual interference is consistent with the biased competition model of visual processing – that there is competition between visual stimuli for attention, and this competition is biased toward some stimuli over others on the basis of novelty, uniqueness, and relevancy (Desimone & Duncan, 1995). Further research also

demonstrated that these attentional effects on visual processing may be specific to visual imagery compared to other internal modalities. Villena-González and colleagues (2016) compared event-related potentials (ERPs) in response to visual input and found stronger attenuation during concurrent *visual* imagery compared to concurrent *auditory* imagery. These findings suggest that visual imagery and visual perception processes may employ overlapping neural resources. In fact, more recent research has found evidence of common patterns of neural activity between visual perception and visual imagery (Pearson, 2019), and significant emphasis has been placed on the visual cortex as the primary region of interest (Dijkstra et al., 2019).

Many of the neural processes that occur during visual perception occur in the visual cortex, a collection of brain regions which include those responsible for detecting basic visual features and combining them into one coherent image. Using multivariate pattern analysis (MVPA) and functional magnetic resonance imaging (fMRI), studies have shown significant overlap between perception and imagery in regions carrying information about object form and object recognition (Albers et al., 2013; Johnson & Johnson, 2014; Stokes et al., 2009), as well as overlap in frontoparietal regions involved in coordinating attention via top-down interaction with visual systems (Dijkstra et al., 2017). For example, Albers and colleagues (2013) were able to decode stimulus identities from activation patterns gathered from fMRI data during imagery. Importantly, these activation patterns resembled those produced during visual perception, suggesting that the imagery that participants produced was “perception-like” in terms of their neural activity. Subsequent research identified brain areas in which similar item-specific information may be represented. Specifically, information about visual scenes was found to be represented within the occipital place area (OPA), retrosplenial cortex, and a portion of the intraparietal sulcus (Johnson & Johnson, 2014). When participants were asked to imagine these

visual scenes, researchers observed very similar areas of activation, suggesting that imagery may be at least somewhat substantiated by the re-instantiation of external visual perceptual information within the visual cortex. Indeed, additional research has shown that stronger imagery vividness resulted in greater overlap of neural activation in early visual areas during perception and imagery (Cui et al., 2007; Dijkstra et al., 2019). Taken together, these results demonstrate that the more similarity between the activation pattern during imagery and the activation pattern for perception, the more vivid the imagery is reported to be.

While some existing research demonstrates the employment of similar neural substrates, there remains significant differential cortical distribution of information when comparing imagery and perception (Dentico et al., 2014; Lee et al., 2012). Thus, while imagery and perception yield similar experiences, the manner in which these experiences are realized is, by most modern neuroscientific theories, necessarily distinct. Most theories of visual perception require the recruitment of bottom-up processing of sensory input; however, in the absence of external stimuli, imagery is mediated by higher-order top-down activation systems (Stokes et al., 2009; Zhou et al., 2023; for one notable exception regarding the direction of information in perception, see Friston, 2010). To illustrate this idea, researchers used electroencephalography (EEG) to demonstrate a reversed signal flow in parieto-occipital networks during imagery when compared with perception (Dentico et al., 2014). Participants in this study both viewed and imagined dynamic scenes which involved components of spatial processing and manipulation, functions for which parieto-occipital areas are heavily implicated. The observation of reversed signal flow in these areas supports the bottom-up versus top-down distinction between perception and imagery and suggests the differential employment of visual pathways. Similar findings were observed by Lee and colleagues (2012) who used fMRI and MVPA to demonstrate

a posterior-anterior gradient along the ventral stream for *perceived* objects, and an opposite anterior-posterior gradient for *imagined* objects. Their results also implicate the absence of bottom-up inputs in the differential processing of imagery compared to perception. Thus, while overlap in areas of activation exists, the contributions of these regions to imagery and perception processes differ, providing an explanation for cases of double dissociation where damage to the brain interrupts visual mental imagery but not visual perception, or vice versa (Lee et al., 2012).

Individual differences in imagery strength can also be differentiated at the structural level. For instance, structural differences in V1 have been found to predict individual differences in the experience of vividness (Bergmann et al., 2016). These researchers conducted a study in which participants' imagery strength was objectively measured using a binocular rivalry paradigm and subsequently compared to both surface area and density of their respective V1 areas. Interestingly, these results revealed that a *smaller* V1 surface area was significantly related to *enhanced* vividness of imagery, implying that the V1 may not play a significant role in the mediation of imagery vividness (Bergmann et al., 2016). This result also suggests the reduction of competing visual input signals, allowing internally driven imagery to be more powerful, and is consistent with the biased competition model of visual perception (Desimone & Duncan, 1995). Based on their findings, Bergmann and colleagues (2016) further suggest that, instead of V1, the vividness of imagery may be mediated by prefrontal areas, which emphasizes the top-down processing of mental imagery. These distinctions allow for the occurrence of individual variation in imagery vividness without compromising visual perception. Further, since the two modalities represent distinct processes, each may also be differentially impacted by psychopathology.

Impact of Psychopathology

Visual Processing. While existing literature supports similar yet distinct employment of neural resources in the processing of internal and external visual information, additional research suggests that visual processing may be impaired in cases of psychopathology. Evidence from behavioural work showed that individuals experiencing a major depressive episode exhibited visual processing deficits in as early stages as the retina, demonstrating reduced contrast discrimination performance compared to healthy controls (Bubl et al., 2009). This same research group later implemented pattern electroretinograms (PERGs) to objectively measure retinal contrast gain (i.e., the retina's ability to adjust its sensitivity to light intensity variations) in patients with major depressive disorder (MDD) and found that they exhibited significant reductions in contrast gain compared to non-depressed controls, and that this effect was positively correlated with depression (Bubl et al., 2010). Interestingly, this reduction was found to normalize following symptom remission via antidepressant treatment (Bubl et al., 2012). Bubl and colleagues (2015) later demonstrated reduced contrast gain at the cortical level by analyzing visual evoked potential (VEP). These results found that individuals with MDD also exhibited reduced VEP amplitude in response to visual stimuli, although to a lesser extent than PERG results, and that this was also correlated with severity measures of depression. Together, these findings suggest alterations in visual processing associated with depression, which may be remediated through treatment and recovery.

Similar observations have occurred in individuals with anxiety disorders. For example, researchers have demonstrated reduced macular cell volumes – responsible for detailed vision – in the retina in individuals with generalized anxiety disorder (GAD; Abdala et al., 2024; Baykara et al., 2024) and panic disorder (Baykara et al., 2022) compared to healthy controls, with posited

links to heightened oxidative stress (Baykara et al., 2022; Baykara et al., 2024) and dysfunctional neurotransmitter systems (e.g., serotonin; Abdala et al., 2024) associated with the pathogenesis of anxiety disorders. Further, using a number of standardized visual function assessments, Ortiz-Peregrina and colleagues (2023) assessed performance on university students who met criteria for GAD (as measured by the Generalized Anxiety Disorder Screener 7) compared to those that did not meet criteria. Results found that anxious students demonstrated lower performance scores on tests assessing speed and accuracy of focus changes, as well as visual acuity. Of note, opposite effects between anxiety and depression have also been observed, with increased macular cell volume associated with higher scores on the Beck Depression Inventory, but reduced macular volumes in GAD (Baykara et al., 2024), suggesting the visual system may be differentially impacted by depression and anxiety.

Thus far, it remains relatively unclear whether these differences in visual processing associated with psychopathology also extend to visual imagery. One study has demonstrated the ability of standard electroretinogram (ERG) to detect retinal activation during visual mental imagery in the absence of an external light stimulus (Kumar & Rajkumari, 2017); however, these findings have not yet been replicated nor applied to psychopathology research. It also remains unclear whether visual perception abilities and limitations extend to visual imagery. Arditi and colleagues (2021) have reported that while participants in their ‘low vision’ group could imagine object details, the distance at which they could resolve features in imagery was significantly shorter, suggesting that imagery may mirror the perceptual limitations of an individual’s vision; however, they did not find a significant relationship between participants’ general visual acuity and their imagery vividness, as measured by the Vividness of Visual Imagery Questionnaire (VVIQ).

At the neural level, a meta-analysis on brain-imaging studies (Lai, 2014) has demonstrated differences in brain activation in response to sad faces between depressed and healthy participants, with depressed participants exhibiting heightened activation in subcortical regions related to emotion recognition and emotional memory (e.g., left striatum, left parahippocampal gyrus), and controls exhibiting greater activation in areas associated with emotion regulation and cognitive control (e.g., left anterior cingulate cortex, left medial and middle frontal gyri, and the thalamus). This suggests that depression is associated with reduced engagement of regulatory areas during visual processing (Lai, 2014). One review of fMRI studies also suggested MDD to be associated with increased hippocampal and decreased anterior cingulate cortex activation during negative visual information processing (Jaworska et al., 2015). The same review also showed *increased* activity of basal ganglia and thalamic structures in response to negative stimuli, but *decreased* activation in response to positive stimuli, suggesting differences in the way positive and negative information is processed in the brain in individuals with MDD. In light of these findings, taken together with overlapping neural systems with visual perception, it is possible that visual imagery in depression may similarly exhibit differential processing of valenced material.

Differences in brain activity in response to emotional visual stimuli in anxiety disorders have also been observed. Researchers have found that individuals with anxiety have demonstrated heightened activity of the amygdala and insula in response to negative visual stimuli compared to neutral stimuli and healthy controls (Shah et al., 2009; Stein et al., 2007). Others have demonstrated reduced top-down connectivity between the PFC and limbic areas (e.g., amygdala and parahippocampal gyrus; Li et al., 2020), as well as the superior frontal gyrus (SFG) and anterior cingulate cortex (ACC; Huang et al., 2022) in individuals with anxiety

compared to controls, suggesting impairments in emotion regulation. Studies have also found distinct neural activations in response to neutral stimuli in individuals with anxiety compared to healthy controls (Li et al., 2020; MacDonald et al., 2025), suggesting differences in the way neutral information is processed in the brain and potentially reflecting a tendency for fear overgeneralization or intolerance of uncertainty – characteristics of anxiety disorders.

Similar research evaluating differential brain activity during mental imagery in depressed and anxious samples, specifically in response to positive and negative stimuli, is limited; however, available neuroimaging research suggests that mental imagery of emotional content is also affected by psychopathology. Individuals reporting high levels of alexithymia – difficulty identifying and describing one’s emotions, common in depressive disorders (Sifneos, 1973) – showed decreased activation in the posterior cingulate cortex (PCC) during happy imagery. The PCC plays a critical role in episodic memory retrieval (Maddock et al., 2001; Sestieri et al., 2011) and the integration of self-referential information (Kelley et al., 2002; Northoff et al., 2006). Importantly, episodic memory and visual imagery are heavily intertwined processes, as the ability to generate vivid mental images often relies on one’s capacity to retrieve detailed episodic content (Cooper & Ritchey, 2022). In this way, diminished PCC activation may point to difficulties in accessing emotionally positive memories, necessary for supporting vivid and emotionally rich imagery (Mantani et al., 2005). Another study showed that individuals with depressive features demonstrated reduced activation in brain regions supporting visual imagery and episodic richness, including the hippocampus, precuneus, and cuneus, even when vividness of imagery was matched with controls (Hach et al., 2014). Participants exhibiting depressive symptoms in this study also demonstrated weaker hippocampal connectivity and increased activation of frontal areas, potentially reflecting compensatory cognitive effort or heightened

self-referential processing (Hach et al., 2014). These findings suggest that even when imagery vividness is similar between individuals with depression and controls, the neural mechanisms supporting imagery are altered, potentially diminishing its emotional and regulatory functions.

Attentional Biases. Depressive disorders are commonly associated with visual attention biases toward negative information (Bradley et al., 1997; Caseras et al., 2007; Matthews & Antes, 1992). For example, Caseras and colleagues (2007) had participants view a series of images of positive, negative, and neutral scenes, and compared gaze maintenance times to healthy controls. They found that dysphoric individuals tended to maintain their attention to negative pictures longer than the non-dysphoric participants. Research has also demonstrated attentional biases not only *toward* negative information but *away from* positive stimuli in individuals exhibiting depressive features (Sears et al., 2010; Winer & Salem, 2016). Evidence from a meta-analysis suggests individuals with depressive disorders show *increased* attention, assessed via eye-tracking, to dysphoric stimuli as well as *decreased* attention to positive stimuli compared to healthy controls (Suslow et al., 2020). In another example, Sears and colleagues (2010) had participants view various emotional images and measured total fixation times in order to assess for differences in the types of stimuli that were attended to. Their results showed that individuals with dysphoric features spent significantly less time attending to positive images than the non-dysphoric controls, again suggesting differences in the processing of positive and negative information.

Similar though inconsistent results have also been observed in individuals with anxiety disorders. Attentional biases are observed in anxiety, particularly toward negative (Becker et al., 2001; Mogg et al., 1995; Veerapa et al., 2020) and threat-related visual stimuli (Bar-Haim et al., 2007; Mogg & Bradley, 1998; Pergamin-Hight et al., 2015), across multiple types of anxiety

disorders, including GAD (Bar-Haim et al., 2007; Becker et al., 2001; Mogg et al., 1995), social anxiety (Becker et al., 2001; Pergamin-Hight et al., 2015), and specific phobia (Bar-Haim et al., 2007; Pergamin-Hight et al., 2015). For instance, a recent meta-analysis (Clauss et al., 2022) of 40 empirical studies found significant relationships between anxiety symptoms and both reflexive orienting toward and maintenance of attention on threat-related faces, images, and words, suggesting not only a tendency for immediate orienting toward negative information, but also difficulty with disengaging from it. Interestingly, some research has suggested that social anxiety in particular is associated with atypical processing of positive social information (e.g., avoidance of positive faces) in addition to hypervigilance toward negative stimuli (Pishyar et al., 2004). For example, Chen and colleagues (2012) tracked participant eye movements during an attentional cueing paradigm using positive, negative, and neutral faces. Their results showed that socially anxious participants were faster to disengage their attention from positive stimuli compared to controls, and that total fixation time for positive stimuli was significantly shorter. However, healthy controls in this study exhibited *longer* total fixation times on emotional stimuli (i.e., both positive and negative), suggesting participants with social anxiety demonstrated an *avoidance* of emotional stimuli. Such results are consistent with other research demonstrating avoidance of emotional stimuli associated with anxiety (Garner et al., 2006). Indeed, Monk and colleagues (2006) assessed attentional biases in individuals with GAD by having them press a button to indicate the location of an asterisk presented following emotional faces and measuring response times. Relative to controls, participants with GAD showed greater reaction times when the asterisk was on the same side as an angry vs. a neutral face, suggesting attentional bias away from negative information. This result is consistent with several other studies that have found no attentional biases for threat in anxiety (Freeman et al., 2000; Gotlib et al., 2004; Rinck et al.,

2003). Such conflicting evidence suggests that attentional biases in anxiety are more variable than what is observed in studies of depression, making it difficult to determine how (and if) such biases extend to or influence the generation and characteristics of visual mental imagery in anxious individuals.

While attentional bias for visual information is often measured through eye tracking, evidence suggests similar methods can be applied to visual mental imagery. Indeed, eye movement occurs while imagining visual scenes, even in the absence of a visual percept, and these movements tend to mirror those made during perception of the same content (Brandt & Stark, 1997; Johansson et al., 2006; Laeng & Teodorescu, 2002; Spivey & Geng, 2001). This suggests that oculomotor behaviour may reflect underlying attentional processes engaged during the construction and exploration of mental imagery. However, while depression and anxiety are characterized by altered patterns of attentional engagement with emotional stimuli, it is uncertain the manner in which these biases extend to internally generated representations, or whether gaze enactment during imagery reflects the same cognitive-affective distortions seen during perception. Moreover, since imagery and perception rely on overlapping yet distinct neural systems, disruption in imagery can occur even when visual perception remains intact. This dissociation highlights the importance of understanding how imagery may uniquely shape emotional experience and appraisal, particularly in the context of psychopathology.

Emotion Appraisal

To best understand the impact of imagery on emotional processes, it is necessary to first discuss the concept of emotion appraisal. The basic premise of many appraisal theories is that emotions are elicited and differentiated based on the content of an individual's environment (Ojha & Williams, 2017). Emotions can be conceptualized as *states* which result from

environmental stimuli (Rolls, 2013). From an evolutionary perspective, emotions can be further described as motivation states which drive an organism to act either to obtain or avoid adaptive (reward) or maladaptive (punisher) stimuli within its environment, implying that certain sensory features trigger an innate and immediate emotional response (LeDoux & Hofmann, 2018; Rolls, 2005, 2013). For example, one need not consciously reflect on the experience of pain in order to evaluate it as a negative experience – it is inherently unpleasant and objectively harmful to the organism. Such stimuli are referred to as *primary reinforcers*, the stimuli which elicit *unlearned* or automatic emotional responses (Rolls, 2005). Secondary reinforcers, on the other hand, refer to stimuli that have become reinforcing due to an association with a primary reinforcer; for example, a tone that regularly precedes an unpleasant stimulus may become a secondary reinforcer. These processes are closely intertwined with emotions. In keeping with the previous example, the tone (secondary reinforcer) associated with an unpleasant stimulus may result in an emotional state, *fear*, which further works as motivation for action to avoid the subsequent stimulus. In this way, emotion appraisal is a cognitive-evolutionary mechanism driven by the evaluation of rewards and punishers and is central to guiding behaviour and decision-making (Rolls, 2013).

While appraisal theories emphasize that emotions arise from evaluations of environmental stimuli in terms of their reward value, alternative models, such as Feldman-Barrett's (2016) theory of constructed emotion, propose that emotions are *not* hardwired responses to environmental stimuli, but rather emergent phenomena constructed from more basic psychological elements, such as basic affect (i.e., valence and arousal) and contextual interpretations. According to this view, emotions are not elicited by objective properties of the external world but are rather inferred based on how bodily sensations are interpreted in light of

past experiences and cultural learning. Whereas appraisal models suggest a more direct relationship between environmental features and emotion, constructed emotion theories posit that emotions are highly context dependent. While the constructed emotion perspective offers valuable insights, the present work primarily adopts an appraisal framework, as it provides a mechanistic and evolutionarily grounded account of emotions particularly suited for examining basic affective dimensions, such as valence (i.e., positive/negative or, alternatively, reward/punishment) in response to both perceptual and internally generated visual content.

In cases of psychopathology – for example, depressive disorders – appraisal theories of emotion implicate a dysfunctional emotion appraisal system as an etiological factor (Mehu & Scherer, 2015; Rolls, 2013; Rolls et al., 2020; Scherer et al., 2022). The appraisal bias model refers to a systematic tendency or disposition to evaluate internal and external events in a way that consistently produces similar and distorted emotion responses, independent of context (Mehu & Scherer, 2015). In a way, it refers to a state of inflexibility of environmental appraisals such that small but important differences across situations are not recognized and thus the situations are evaluated as the same. This type of rigidity results in a persistent experience of the same emotion state and behavioural response to situations that might otherwise be distinct. In depression, this model proposes that negative appraisal biases increase the frequency at which depressive episodes (e.g., episodes of sadness and despair) are experienced and therefore increase the risk of developing disorder (Mehu & Scherer, 2015). A similar relationship is proposed between dysfunctional appraisal and anxiety disorders, particularly in biases in processing threat-related information (Liu et al., 2019; Mogg & Bradley, 1998; Scherer et al., 2022). Thus, if both depression and anxiety are associated with attentional biases toward negative information – and, in depression, away from positive information – it follows that each

may be associated with a generalized negative appraisal bias. Indeed, Scherer and colleagues (2022) tested the relationship between appraisal bias and various emotion states and observed that negative appraisal biases were significantly associated with a higher risk for the development of depression and anxiety.

Interestingly, researchers have also suggested that appraisal processes – and therefore, appraisal biases – extend to imagined scenarios as well (Ellsworth & Scherer, 2003), reasoning that no matter the nature of the stimulus, similarity in content is likely to result in similar appraisals, and thus, similar experiences of emotion (Robinson & Clore, 2001). Indeed, Robinson and Clore (2001) explored the convergence of emotion ratings between imagined emotional scenes and real emotional images and found no differences in the emotions elicited by the two different types of stimuli. More recent research has further demonstrated that perceptual and imagined stimuli engage in learning processes in similar ways (Burleigh et al., 2022). Specifically, these researchers found not only that conditioned fear responses acquired via visual stimuli generalize to matching imagined stimuli, but also that conditioned fear responses acquired via *imagery* generalize to matching *visual* stimuli, as indicated by both self-reports of fear and measures of physiological arousal. This suggests that the same learning processes that occur for secondary reinforcers in emotion appraisal for the external world, may also generalize to appraisals of the internal world (i.e., imagery).

Imagery and Emotions

One of the most crucial aspects of mental imagery is its heightened ability to induce affective states (Skottnik & Linden, 2019), even to an extent beyond exteroceptive sensation (Holmes & Matthews, 2005; Holmes et al., 2008a). For example, healthy participants in Holmes and Matthews (2005) reported greater increases in feelings of anxiety in response to imagining

unpleasant scenarios compared to listening to verbal descriptions of unpleasant scenarios, suggesting that the emotional content within the mental imagery was more salient than that contained in the verbal stimuli. This finding was further demonstrated in a similar study, where the use of an image-word paradigm allowed researchers to observe a heightened emotional experience in response to emotional stimuli following imagery than after written sentence presentations (Holmes et al., 2008a).

The impact of imagery on emotion is further supported through psychophysiology work specifically targeting aphantasia (i.e., the absence of visual imagery). Wicken and colleagues (2021) measured electrodermal activity (EDA) of participants during perceptual- and imagery-based tasks intended to elicit feelings of fear and compared individuals with aphantasia and normal imagers. Both participant groups demonstrated significant EDA responses when perceiving fearful scenes, but this response was weakened during the imagination of fearful scenarios for the aphantasia group only. In other words, experiencing little to no imagery strength resulted in weaker physiological reactivity in response to imagined fearful scenarios, but not perceived fearful scenarios. These results suggest that the decrease in physiological response was due to the absence or weakness of the mental imagery and *not* a general dampening of affectivity.

Imagery and Mental Illness

The affective nature of mental imagery and its influence on emotional symptoms in various psychopathologies has become a growing area of research. For instance, reports of intrusive mental images of aversive events are associated with a number of emotional disorders. In post-traumatic stress disorder (PTSD), for example, flashbacks – sudden imagery related to a traumatic event – evoke powerful negative emotions (Breslau, 2009; Bryant & Harvey, 1996).

Similarly, vivid and intrusive concern-related images are a predominant component in anxiety- (Hirsch & Holmes, 2007; Pile & Lau, 2020), phobia- (Ashbaugh et al., 2019; Homer & Deeptose, 2017; Price et al., 2012), and obsessive-compulsive-related disorders (Lipton et al., 2010; Rachman, 2007; Speckens et al., 2007). For example, participants with social phobia experience consistent negative and disturbing images when in anxiety-provoking situations (Hackmann et al., 1998). Indeed, mood and anxiety disorders are particularly marked by dysfunctional emotion systems that are greatly influenced by mental imagery.

Negative and intrusive imagery is reported by patients in nearly all anxiety disorders, with content reflecting their primary fears or concerns (Ashlen & Abbott, 2016; Hirsch & Holmes, 2007; Hirsch et al., 2012). For example, in social anxieties, imagery often involves oneself exhibiting symptoms of anxiety, such as sweating or shaking. In depressive disorders, negative intrusive imagery is also quite common (Holmes et al., 2016). For example, Patel and colleagues (2007) reported that nearly half of their participants with MDD experienced frequent and distressing intrusive images of memories and imagined events. Other research has demonstrated that the imagery experienced by those with depression results in higher levels of emotional distress compared to never-depressed controls (Görge et al., 2015; Newby & Moulds, 2011); however, these results may be a function of increased susceptibility to emotional distress observed in depressive disorders (for a review, see Lass & Winer, 2020).

In terms of emotional learning theories, the inability to obtain an expected reward often gives rise to feelings of sadness or despair (Rolls, 2016). In addition, according to a review by Rolls and colleagues (2020), depression has also been associated with *enhanced* activity and functional connectivity of the lateral orbitofrontal cortex (lOFC) – associated with non-reward processing – and *reduced* activity and functional connectivity of the medial orbitofrontal cortex

(mOFC) – associated with reward processing. Further, these regions are part of the prefrontal cortex, a collection of brain areas which have been broadly implicated in mediating imagery vividness (Bergmann et al., 2016). This suggests that depression may be associated with increased sensitivity to non-rewarding/punishing stimuli and *decreased* sensitivity to rewarding stimuli. Importantly, individuals with depression also report a phenomenon of significantly reduced vividness for positive imagery (Holmes et al., 2008b; Morina et al., 2011; Pile & Lau, 2018; Stöber, 2000). For instance, Stöber (2000) demonstrated that participants with higher scores on measures of depressive symptoms reported impoverished vividness for positive, but not negative, events. Similar results were found by Holmes and colleagues (2008b) and Pile and Lau (2018), where researchers observed that participants with higher levels of depressed mood exhibited poor ability to imagine positive (but not negative) future events compared to controls (Holmes et al., 2008b) and individuals with anxiety (Pile & Lau, 2018). Thus, if depression is characterized by sensitivity to punishment and reduced sensitivity to reward – and attentional biases toward negative and away from positive information – it follows that negative imagery would be more salient and that positive imagery would be less salient in individuals with depression. However, whether the emotional salience of a mental image is related to or independent from the vividness of a mental image remains unknown.

A similar distinction in imagery ability was observed in individuals with anxiety, where anxious participants experienced enhanced vividness for imagery of negative events beyond that experienced by the depressed participants (Stöber, 2000). This result was replicated in a subsequent study by Morina and colleagues (2011) in which individuals with anxiety disorders demonstrated a superior ability to produce vivid imagery for negative scenarios beyond that of both controls and individuals with MDD. Interestingly, this study reported that individuals with

anxiety also experienced reduced vividness for positive events; however, this finding is complicated by significant overlap between participants' depression and anxiety scores in the sample and is not consistent with previous research exploring these effects (MacLeod, 1996; Pile & Lau, 2018). Importantly, existing research on valence-specific imagery functioning in depression and anxiety contexts (Holmes et al., 2008b; Morina et al., 2011; Pile & Lau, 2018; Stöber, 2000) has not yet explored imagery manifestations in cases specific to comorbid depression and anxiety, nor has it compared these effects to actual visual stimuli (e.g., pictures). Thus, it remains uncertain whether valence-specific imagery vividness exhibits additive or dominant effects in cases of comorbidity, and whether dysfunctions in imagery extend to or are distinct from dysfunctions in perceptual processing associated with psychopathology (e.g., Abdala et al., 2024; Baykara et al., 2022; Baykara et al., 2024; Bubl et al., 2009, 2010, 2015).

These findings, taken together with earlier evidence of shared yet distinct neural mechanisms underlying imagery and perception (see *Imagery vs. Perception* section above), suggest that the emotional impact of mental imagery in psychopathology may not simply reflect deficits in perceptual processing, but rather a unique vulnerability related to the generation of visual imagery. In particular, attentional processes may play a central role in mediating the salience and persistence of these internal representations. Evidence from both behavioural and neuroimaging studies indicates that individuals with depressive and anxious symptoms often exhibit attentional biases toward negatively valenced stimuli (Bar-Haim et al., 2007; Becker et al., 2001; Bradley et al., 1997; Caseras et al., 2007; Matthews & Antes, 1992; Mogg et al., 1995; Pergamin-Hight et al., 2015; Veerapa et al., 2020), and in some cases, that depression exhibits biases away from positively-valenced stimuli (Sears et al., 2010; Suslow et al., 2020). If similar biases are engaged during mental imagery, they could facilitate the selective generation of

negative and positive imagery, contributing to mood-congruent distortions in affect and cognition (Ji et al., 2017; Skottnik & Linden, 2019). This interplay between attention, imagery vividness, and emotional valence may constitute a feedback loop that exacerbates symptom severity in those expressing depressive and anxious features. In addition, while literature suggests valence-specific vividness for imagery in depression and anxiety (Holmes et al., 2008b; Morina et al., 2011; Pile & Lau, 2018; Stöber, 2000), little is known about how these processes interact in individuals experiencing comorbid depression and anxiety. Given high rates of comorbid mood and anxiety disorders (Saha et al., 2021) and the possibility of opposing or interacting biases (e.g., Morina et al., 2011; Pile & Lau, 2018; Stöber, 2000), it remains unclear whether the effects on imagery vividness in such cases are additive or governed by one dominant pattern. Clarifying these dynamics could improve our understanding of how internal representations contribute to the maintenance and complexity of mood and anxiety disorders.

The current study aimed to address these issues by examining cognitive and affective responses to both imagined and perceived visual emotional stimuli. Participants completed an emotion appraisal task where, in two separate blocks, they were presented with either real images or written imagery cues and subsequently asked to rate the emotional valence of each stimulus. During imagery trials, participants rated the vividness of each mental image generated, and during perception trials, participants rated the clarity of each image presented. In this study, vividness and clarity were treated as parallels in that both inquired about the clearness and level of detail of the stimuli, with the distinction that “vividness” refers to internally generated visual content and “clarity” refers to externally generated visual content. Task performance was assessed with reference to scores on standardized severity measures of depression and anxiety to

test whether participants exhibit vividness differences on the bases of valence and presenting clinical features.

This experimental design allowed for the exploration of whether individuals with varying levels of depressive, anxious, and comorbid features exhibit valence-specific differences in imagery vividness. In line with prior research, we hypothesize that elevated levels of depressive and anxious features will be associated with heightened vividness of negative imagery, with anxious features exhibiting a stronger association (Morina et al., 2011; Stöber, 2000). We also expect that higher levels of depressive symptoms will predict diminished vividness for positive imagery (Holmes et al., 2008b; Pile & Lau, 2000; Stöber, 2000), consistent with evidence of attention avoidance of positively valenced stimuli in depression (Sears et al., 2010; Suslow et al., 2020). Additionally, due to high rates of comorbidity between depressive and anxiety disorders, and limited empirical evidence addressing their joint impact, we explored the possibility that comorbid presentations may exhibit a unique or interactive pattern of vividness across valence. For instance, comorbidity may produce additive effects (e.g., heightened vividness for negative imagery alongside reduced vividness for positive imagery) or reflect dominance of one disorder's profile over the other. Understanding these dynamics may shed light on the role of internal representations in the maintenance and complexity of mood and anxiety symptoms. This design also allowed for the *comparison* of internal and external visual experiences, specifically in terms of participants' subjective experiences of emotion and stimulus vividness/clarity, in cases of self-reported depressive, anxious, and comorbid symptomatology.

Given the complexity of affective and cognitive processes implicated in depression and anxiety, the current study employed both dimensional (correlation, regression) and multidimensional (classification) analytic strategies to evaluate the predictive utility of imagery

vividness, perceptual clarity, and valence ratings. The dimensional approach, operationalized through linear multiple regression, treated depression and anxiety symptoms as continuous variables and estimated how well individual predictors explained variance in symptom severity. This strategy allowed for the assessment of the relative contribution of each variable while holding others constant, which is useful for identifying unique associations between features and symptom severity. However, this univariate focus may limit the ability to capture the predictive utility of the complex interactions between cognitive and perceptual variables that likely underlie affective symptomatology.

To address this, a complementary multidimensional approach was implemented using classification modeling. In this analysis, the outcome variable was a categorical construct that combined participants' depressive and anxious symptom severity and considered all relevant variables (i.e., valence, vividness, and clarity) *simultaneously*. This strategy also allowed for the simultaneous prediction of comorbid symptom profiles, reflecting real-world overlap between mood and anxiety disorders. Importantly, this classification framework was designed to leverage the joint predictive capacity of cognitive, affective, and perceptual features, with the goal of determining whether the combination of these features is more informative for predicting categorical disorder severity classifications than any one feature in isolation.

By comparing these two analytic strategies, the current study aimed to clarify whether the continuous modeling of symptom severity or the categorical prediction of combined symptom profiles better captures the contribution of internally and externally derived affective and sensory processes. While dimensional strategies via regression modeling are more consistent with contemporary models of psychopathology, such as the Research Domain Criteria (RDoC; Insel et al., 2010) and the Hierarchical Taxonomy of Psychopathology (HiTOP; Kotov et al., 2017),

disorders are often still described – colloquially by academics, as well as the general population – as a categorical grouping; something that one ‘has’ or ‘does not have,’ suggesting defined impairment in psychopathology. Accordingly, this study sought to explore whether classification models that incorporate multidimensional variable structures lend any empirical support to traditional categorical approaches to psychopathology, or whether such categorizations may represent oversimplified or potentially misleading labels that obscure the underlying dimensional nature of symptom expression.

Methods

Participants

Participants ($N = 173$) were recruited through the Lakehead University online research participation portal. Of these, $N = 5$ failed to complete the study properly, and $N = 1$ withdrew prior to completing the experiment, resulting in a final sample size of $N = 167$. The average age of remaining participants was $M = 22$ years ($SD = 5.38$, range = 17 to 40). Approximately 73% ($N = 122$) of the sample self-identified their gender as female, 25% ($N = 42$) self-identified as male, and 1.8% ($N = 3$) self-identified as non-binary. A priori power analysis was conducted for the primary statistical analyses: a linear multiple regression with 12 predictors, using G*Power 3.1 (Faul et al., 2009). The analysis identified a required minimum sample size of $N = 81$ to detect a medium effect ($f^2 = 0.25$) with an alpha level of .05 and power of .80. All participants were fluent in English; multilingualism was not considered a criterion for inclusion or exclusion. All participants had normal or corrected-to-normal vision. Participants received either course credit or an entry in a draw for a \$100 CAD Amazon gift card. All procedures were approved by

the Lakehead University's Research Ethics Board (REB-ID: 1470107). Participants provided informed consent prior to participation and were debriefed upon completion of the study.

Scales

Beck Depression Inventory

To assess the presence of depressive features, participants completed the Beck Depression Inventory-II (BDI-II; Beck et al., 1996). The BDI is a 21-item self-report questionnaire that measures the severity of various features of depression and is intended to include items that minimize symptom overlap with anxiety (Beck et al., 1961). It was revised in 1996 to be more congruent with DSM-IV criteria for a major depressive episode (i.e., symptoms must be present for at least two weeks; American Psychiatric Association, 1994) such that participants are now asked to reflect on the *past two weeks* rather than the previous one-week timeframe in the original version. It also includes clinical cut points for levels of overall severity, with scores of 0 to 13 indicating minimal depression, 14 to 19 indicating mild depression, 20 to 28 indicating moderate depression, and 29 to 63 indicating severe depression (Beck et al., 1996).

To complete the questionnaire, participants responded to each item by rating the severity of the targeted symptom on a four-point Likert-type scale ranging from 0 (absent) to 3 (severe). The extent of depressive features for each participant was indicated from their total score on the BDI-II, with high scores (maximum = 63) indicating greater severity. Importantly, this measure is *not* a diagnostic tool and, therefore, no judgments were made regarding a diagnosis of depression for any participant. At the request of the overseeing ethics board, Item 9, which inquires about suicidality, was removed from the questionnaire in order to avoid provoking negative thoughts and emotions, resulting in a new maximum BDI-II score of 60.

With respect to the overall psychometric quality of the BDI-II (Beck et al., 1996), researchers found that the content validity has improved from the first edition due to item replacement and rewording that better reflects DSM-IV criteria, with mean correlation coefficients of 0.72 and 0.60 between clinical ratings of depression and BDI scores for psychiatric and non-psychiatric populations (Jackson-Koku, 2016). Additionally, this study found that the BDI-II construct validity is high in both psychiatric patients and college students ($\alpha = .92$ and $.93$, respectively), and that it demonstrated good concurrent validity with the Minnesota Multiphasic Personality Inventory-Depression scale (MMPI-D; $r = .77$) and good criterion validity with the Hamilton Depression Rating Scale ($r = 0.71$). Finally, this study reported that the internal consistency of the questionnaire is estimated at $\alpha = .91$ with a test-retest coefficient of $r = .93$.

Beck Anxiety Inventory

The Beck Anxiety Inventory (BAI; Steer & Beck, 1997) was used to assess the presence of various features of anxiety. Like the BDI-II, the BAI is a 21-item self-report questionnaire measuring the severity of anxiety symptoms and is designed to differentiate anxiety from depression (Bardhoshi et al., 2016). The BAI offers severity cut points, with scores of 0 to 7 suggesting minimal anxiety, 8 to 15 suggesting mild anxiety, 16 to 25 suggesting moderate anxiety, and 26 to 63 suggesting severe anxiety; the manual also suggests a cut-off score of 16 for clinically significant anxiety (Beck & Steer, 1993; as cited in Carney et al., 2011).

To complete the questionnaire, participants indicated the extent that they have been bothered by the symptom described in each item on a four-point Likert-type scale where 0 = *not at all bothered* and 3 = *severely bothered*. The extent of anxious features for each participant were indicated from their total score (max. = 63) on the BAI, with higher scores indicating

greater severity (Steer & Beck, 1997). As with the BDI-II, the BAI is not considered a diagnostic tool and, therefore, no judgments were made regarding a diagnosis of anxiety for any participant.

Overall, the psychometric quality of the BAI has also shown to be good. In a meta-analysis, the average internal consistency across studies was estimated at $\alpha = .91$ (95% CI [.90, .92]) with an average test-retest coefficient of .65 (Bardhoshi et al., 2016). This analysis also reported that convergent validity is acceptable with an average correlation coefficient of $r = .57$ across 12 studies comparing the BAI with the Hamilton Rating Scale for Anxiety (HAM-A). Additionally, it demonstrated correlations between the BAI with the State-Trait Anxiety Inventory (STAI), with average coefficients of $r = .53$ for the State subscale and $r = .56$ for the Trait subscale across 12 studies.

Vividness of Visual Imagery Questionnaire

To assess general imagery ability, participants completed the Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973). This measure consists of 16 items to be completed in two separate conditions – once with the eyes open and once with the eyes closed – for a total 32 items and possible scores ranging from 16-80. To complete the VVIQ, participants were instructed to form mental images, in their minds, of scenes described in each item and subsequently make a rating to indicate the vividness of that imagined image. Ratings were made on a four-point Likert-type scale ranging from 1 (*perfectly clear image, as vivid as normal vision*) to 5 (*no imagery present at all, you only know that you are thinking of the object*). After reverse scoring, *low* scores on the VVIQ indicate *weaker* imagery ability while *high* scores indicate *stronger* imagery. The contents of items 1-4 involve thinking of a friend or relative, items 5-8 involve visualizing a sunrise, items 9-12 involve imagining a store that is visited frequently, and items 13-16 involve visualizations of country scenes including lakes, mountains,

and trees. While the concepts of aphantasia and hyperphantasia did not exist at the time of the VVIQ's development, recent studies have identified approximal cut-off scores to classify these imagery extremes. Since a total score of 32 is equivalent to rating every item on the VVIQ as "Vague and dim," most definitions of aphantasia are defined as scores ranging from 16 to 32 (Dance et al., 2022; Dawes et al., 2020; Keogh et al., 2021; Wicken et al., 2021; and Zeman et al., 2020). Definitions of hyperphantasia as indicated by the VVIQ are more difficult to come by; however, most definitions include scores ranging from 75 to 80 (Larner et al., 2024; Milton et al., 2021; Zeman et al., 2020).

The psychometric quality of the VVIQ is good and has been shown to be comparable to more recent editions, such as the VVIQ-2 and the VVIQ-Revised Version (VVIQ-RV). Specifically, Campos and Perez-Fabello (2009) reported an internal consistency coefficient of $\alpha = .91$, which is similar to the VVIQ-2 ($r = .93$). Test-retest reliability is reported as .74, with a split-half reliability coefficient of .85. Additional comparisons of the first edition to the VVIQ-2 and -RV show that neither of the new versions have improved upon the original in terms of its psychometric properties (Campos, 2011).

Stimuli and Apparatus

Imagery Cues

The imagery cues for this experiment were adapted from a list of cues used in a previous study (see MacLeod, 1996) examining the manner in which mood disorders affect future-oriented thinking. Specifically, the stimuli were adapted to be present tense as opposed to their original future tense format such that the task targeted immediate emotion appraisal rather than appraisal of a potential future event to be more comparable with the picture appraisals (see below), which necessarily occur in real-time. For example, "You will fall badly behind in your

work,” becomes “You are falling badly behind in your work,” and “You will have lots of energy and enthusiasm,” becomes, “You are energetic and enthusiastic.” In addition, all imagery cues were phrased so that the content is first-person relevant (i.e., using “You...” statements; Velasco & Bond, 1998). For a full list of imagery stimuli, see Appendix A.

To validate that these changes did not significantly impact the intended valence of the stimuli, a pilot study was conducted on the adapted imagery cues wherein participants rated how positive or negative the imagery made them feel to ensure the original intended valence had carried over. Based on initial pilot testing ($N = 4$), these stimuli were confirmed to represent distinct valence categories ($p < .001$), with positive and negative cues demonstrating similar absolute deviation from neutral ($p = 0.295$). Each valence category consisted of 5 unique imagery cues for a total of 15 cues. For each individual participant, no stimuli were repeated during the experiment.

Pictures

Pictures used in this experiment were chosen from the Open Affective Standardized Image Set (OASIS) database based on valence and arousal information (Kurdi et al., 2017). Positive picture stimuli had an average valence rating of $M = 6.32$ (range = 6.22 to 6.49) and average arousal rating of $M = 4.9$ (range = 4.74 to 5.03); negative picture stimuli had an average valence rating of $M = 1.39$ (range = 1.26 to 1.41) and average arousal rating of $M = 4.96$ (range = 4.86 to 5.02); and neutral picture stimuli had an average valence rating of $M = 4.00$ (range = 3.99 to 4.01) and average arousal rating of $M = 1.345$ (range = 1.209 to 1.476). For each valence level (i.e., positive, neutral, negative), 5 pictures were selected, with no overlapping themes within valence categories, for a total of 15 unique stimuli (see Table 1). To avoid the potential effects of repeated exposure, each image was presented a single time in an experimental run. Using OASIS

information, a one-way ANOVA revealed the selected pictures to represent distinct valence categories ($p < .001$) and independent t -tests determined that the selected positive and negative pictures maintained equivalent arousal levels ($p = .38$). Paired sample t -tests based on OASIS information indicated that positive ($M = 2.32$, $SD = 0.11$) and negative ($M = 2.61$, $SD = 0.14$) mean valence ratings did not represent similar absolute deviation from neutral ($p = .007$); however, paired sample t -tests on pilot sample valence ratings standardized to the experimental rating scale indicated similar distance from neutral ($p = .96$). All stimuli (pictures and imagery cues) were displayed against a grey background on a 1920x1080 pixel Acer monitor with a viewing distance of ~40 centimeters. Images had an approximate viewing angle of 20° below eye-level.

Table 1*Picture Stimuli Descriptives*

Valence Category	Item	Image Theme	M (SD)
Positive ($M = 0.84$; $SD = 0.17$)	1	Dog	0.86 (0.15)
	2	Fireworks	0.85 (0.18)
	3	Rainbow	0.89 (0.13)
	4	Cat	0.78 (0.20)
	5	Beach	0.82 (0.18)
Negative ($M = 0.21$; $SD = 0.21$)	1	War	0.45 (0.18)
	2	Rally	0.08 (0.10)
	3	Dirt	0.20 (0.20)
	4	Tumor	0.18 (0.19)
	5	Dog	0.15 (0.17)
	1	Dirt	0.51 (0.11)

Neutral ($M = 0.51$; $SD = 0.12$)	2	Cardboard	0.51 (0.14)
	3	Storage	0.52 (0.10)
	4	Paperclips	0.53 (0.14)
	5	Walls	0.49 (0.12)

Note. This table provides a summary of the correlation coefficients for each of the primary hypotheses. Values denoted by ‘*’ are statistically significant at $\alpha = .05$. Values in parentheses reflect partial correlation results controlling for BDI-II scores.

Procedure

Questionnaires

Participants began the experiment by completing a questionnaire battery, which included a brief demographics questionnaire, the BDI-II, the BAI, and the VVIQ. Participants were given privacy while completing the questionnaires, with the experimenter available in the case participants required assistance or clarification.

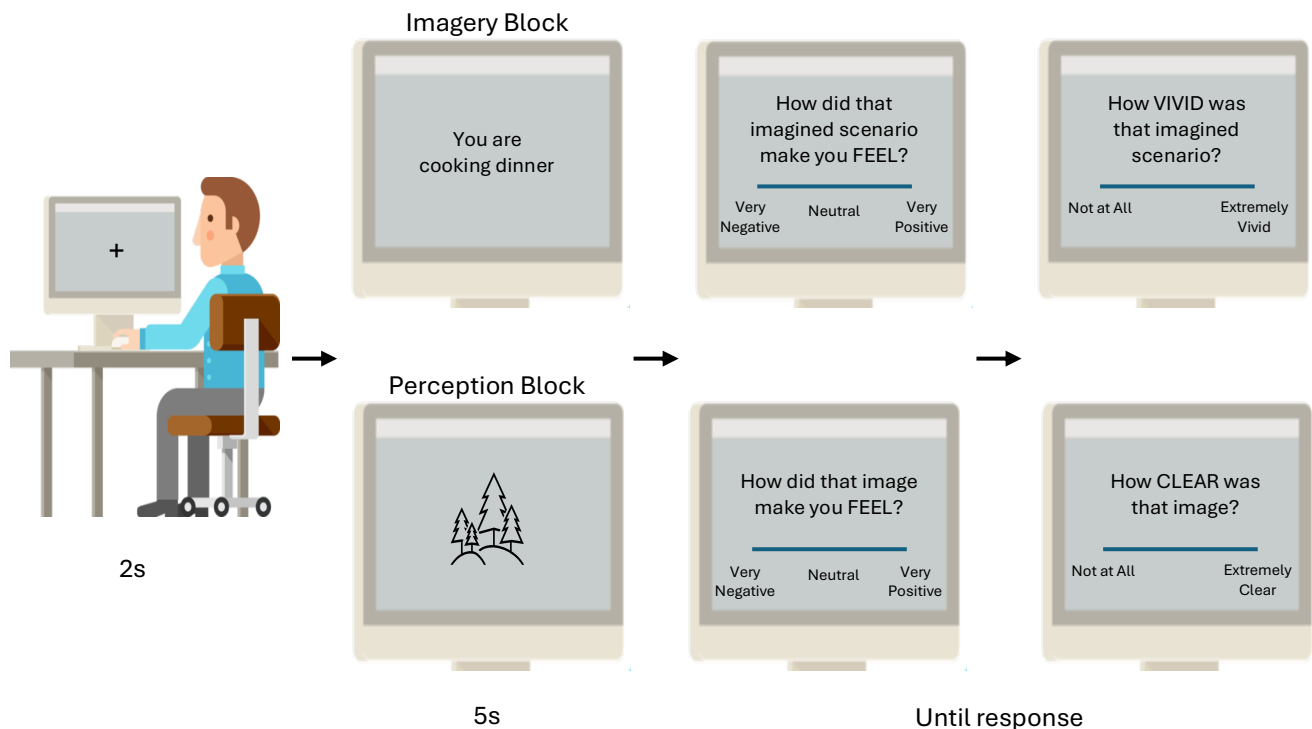
Emotion Appraisal Task

The primary experimental task consisted of two separate blocks – an imagery block and a perception block – with order counterbalanced between participants (Figure 1). In the imagery block, participants were instructed to form mental images based on a set of short phrases and subsequently rate the valence and vividness of each mental image. Once an imagery cue was presented, participants had five seconds to form a mental image while keeping their eyes open. The imagery cue remained on the screen for the duration of each visualization period. Once the cue disappeared from the screen, two rating screens appeared sequentially, allowing the participant to make their valence (*Very Negative* to *Very Positive*) and vividness (*Not At All* to *Extremely Vivid*) judgments on an analog scale. The order in which the rating screens appeared was the same for each trial in both experimental blocks and across all participants.

In the perception block, participants were presented with a randomized series of fifteen pictures for five seconds each. Following each picture presentation, the same two rating screens that were included in the Imagery block also appeared here, sequentially, allowing the participant to make their valence (*Very Negative* to *Very Positive*) and clarity (*Not At All* to *Extremely Clear*) judgments on an analog scale. Clarity ratings allowed for the assessment of subjective perceptual experiences across emotional contexts, as well as providing symmetry in timing and cognitive load across experimental blocks. Valence and clarity ratings for picture stimuli were recorded in the same manner as in the Imagery block. All tasks were custom programmed using PsychToolbox (v3.0.19) for MATLAB v.R2024b and run on an Acer Aspire A515-45 laptop.

Figure 1

Progression of Experimental Trials



Note. This figure depicts the progression of experimental trials. Both experimental blocks begin with a fixation cross (2s). The top series shows the sequence of screens displayed in the imagery block. The bottom sequence shows the sequence of screens displayed the perception block.

Analyses

Measures of interest for this work include questionnaire metrics (i.e., the BDI-II and BAI), as well as the valence, vividness, and clarity ratings for each block. BDI-II and BAI responses were summed and used as measures of depressive and anxious features, respectively. To derive an index of comorbidity between depressive and anxious features, the product of each participant's total scores on the BDI-II and BAI was computed. This multiplicative approach allows for higher values to reflect elevated symptomatology in both disorder domains and better differentiation between various symptom presentations across participants. For instance, unlike the sum of two scores – which could yield high scores even when one domain (e.g., depressive features) is high and the other (e.g., anxious features) is low – the product score better emphasizes cases in which both depressive and anxious features are concurrently elevated.

The VVIQ provided a standardized measure of individual differences in imagery ability to be used to evaluate the relationship between general imagery vividness with disorder constructs, as well as a point of comparison to assess convergence with vividness ratings collected during the experimental task. Valence and vividness ratings were recorded as a proportion of the selected point on the visual analog scale such that 0 (the left-most end of the scale) indicated an extremely negative or unclear rating for valence and vividness, respectively, and 1 (the right-most end of the scale) indicated an extremely positive or vivid rating. For valence ratings, a value of 0.50 represented truly neutral valence. Valence ratings from each block were compared to test whether positive, negative, and neutral items were rated similarly across imagery and perceptual stimuli; valence ratings *within* each block were compared to ensure they were significantly differentiated from one another; and valence ratings within each valence category were compared to ensure individual items performed similarly.

Correlations

Correlation analyses tested whether participants' scores on each of the severity measures (i.e., BDI-II and BAI) were associated with the vividness of valenced imagery. Specifically, Spearman correlations tested the strength and direction of association between total BDI-II and BAI scores with average vividness ratings for stimuli within each valence category across participants. Based on previous findings (e.g., Stöber, 2000), it was expected that BDI-II scores would be significantly and negatively correlated with vividness ratings for positive imagery stimuli, and that BAI scores would be significantly and positively correlated with vividness ratings for negative imagery stimuli. Additionally, based on the nature of the disorders, it is likely that vividness ratings for negative stimuli will be elevated (compared to individuals with low rates of disorder features) in both depressed and anxious individuals, but it is expected that those high in anxious features will report increased vividness beyond that of the depressed individuals (congruent with results from Morina et al., 2011 and Stöber, 2000). Correlations will also inform the relationship between comorbidity and vividness ratings for valenced imagery; however, this particular analysis is exploratory and, thus, no predictions were made regarding the nature of these relationships. All correlations were conducted using the “psych” package (Revelle, 2015), and partial correlations were obtained using the “ppcor” package (Kim, 2015), in the statistical software, R (R Core Team, 2021).

Regressions

Linear multiple regression analyses tested whether participants' scores on the severity scales, as well as their comorbidity index, separately, could be reliably predicted by valence and vividness ratings for valenced stimuli. Mean valence and vividness/clarity ratings for stimuli within each experimental block and valence category were included in the initial model to assess

how participants' affective sensory processing relates to symptom severity and comorbidity. By incorporating both imagery- and perception-based ratings, the initial model accounts for potential contributions of individual differences in how emotional stimuli are experienced and represented across similar yet distinct modalities. In other words, it tests whether the predictive relationship between valenced stimulus processing and depressive, anxious, and comorbid outcomes are modality-specific or generalizable across internal (imagery) and external (picture) visual information. In addition, since the primary goal of the study was to specifically assess the relationship between imagery vividness and depressive, anxious, and comorbid features, further regression analyses will test whether valence-specific imagery vividness alone uniquely contributes to the prediction of disorder severity and comorbidity.

In line with expectations for correlation analyses, it is expected that vividness ratings for positive imagery will demonstrate significant predictive capacity for total BDI-II scores, and that vividness ratings for negative imagery will demonstrate a significant predictive capacity for BAI scores. Since existing literature does not assess comorbidity directly, the current study provided no specific predictions regarding the predictive capacity of vividness ratings for participants' comorbidity indices. All regression analyses were conducted using the “Stats” package in R (R Core Team, 2021).

Classifications

While regression analyses tested the independent predictive capacity of variables of interest on continuous severity outcomes (i.e., a dimensional approach), classification analyses tested whether all variables simultaneously could be used to classify participants into predefined classes (i.e., a multidimensional approach). To define classes, participants were categorized into groups based on their total BDI-II and BAI scores. Participants were first labeled as *high* (BDI-II

$M = 25.96$; BAI $M = 30.12$) or *low* (BDI $M = 7.23$; BAI $M = 7.50$) on each of the measures based on a median split (BDI-II median = 14; BAI median = 16), such that individuals with total scale scores greater than or equal to the median were considered *high* in depressive or anxious features and those with total scale scores below the median were considered *low* in depressive or anxious features. Wilcoxon rank-sum tests determined *low* and *high* groups for the BDI-II and BAI scales to have significantly different average total scale scores ($p < .001$).

While the median splits do correspond nicely with established clinical cut-points, the severity levels to which they correspond are different, and interpretation of these cut-points as they relate to the current data is complicated by the removal of item 9 on the BDI-II, which reduced its maximum possible score. Specifically, the BDI-II median corresponds with the cut-off score indicating *mild* depression, while the BAI median corresponds to the cut-off score indicating *moderate* anxiety. Despite these differences, the median split approach was selected because it allowed for data-driven group formation that ensured approximately equal group sizes, thereby maintaining statistical power. Moreover, the aim was not to make conclusions about specific severity thresholds but to examine the relative differences in symptom severity on a continuous scale; thus, the median split served as an appropriate strategy for identifying participants with comparatively higher versus lower symptomatology on each scale without compromising statistical power.

Following initial groupings based on individual scales, participants were further categorized into one of four combined severity groups (Table 2). Those scoring below the median on both the BDI-II and the BAI were labeled *low-low* ($N = 68$), reflecting low symptomatology in both depressive and anxious features; those high on the BDI-II but low on the BAI were labeled *high-low* ($N = 17$), reflecting predominantly depressive symptomatology;

those low on the BDI-II but high on the BAI were labeled *low-high* ($N = 21$), reflecting predominantly anxious symptomatology; and those scoring above the median on both scales were labeled *high-high* ($N = 61$), reflecting highly comorbid symptomatology.

Table 2*Classification Group Descriptives*

Group	<i>N</i>	BDI-II	BAI
		<i>M (SD)</i>	<i>M (SD)</i>
low-low	68	6.27 (4.21)	7.20 (4.01)
high-low	17	18.63 (4.05)	8.71 (5.07)
low-high	21	10.33 (2.90)	25.19 (7.12)
high-high	61	28.00 (9.18)	31.82 (10.08)

Note. This table provides descriptive statistics for classification groups.

The classification model implemented a Naïve Bayes classifier to examine whether participants could be reliably classified into severity groups based on their valence and vividness/clarity ratings across both experimental blocks. The model used 8-fold cross-validation to assess generalizability and reduce the risk of overfitting. To evaluate statistical significance of the classification accuracy, a permutation test with 1000 iterations was conducted, generating a null distribution of accuracy scores under random label (i.e., severity group) assignment. In alignment with the study's primary hypotheses, a second and identical classification model was implemented using only the valenced vividness ratings for imagery stimuli to classify participants into severity groups, reducing statistical noise from additional variables. Each classification model was expected to produce an achieved accuracy greater than the theoretical chance level (i.e., 25%). However, statistical significance was evaluated by comparing the

observed accuracy for each model to a null distribution of accuracies generated through permutation testing, providing a more robust estimate of model performance under random label assignment. Classification analyses were conducted using the “caret” (Kuhn, 2008), “e1071” (Meyer et al., 2024), and “naivebayes” (Majka, 2024) packages in R (R Core Team, 2021).

Results

Manipulation Checks

To assess whether experimental stimuli and questionnaire-based measures functioned as intended, a series of manipulation checks were conducted. These checks aimed to determine whether stimuli were comparable across experimental blocks, whether they aligned with their intended valence categories, whether valence categories were reliably differentiated from one another, and whether stimuli within each valence category were rated similarly. Normality checks using Shapiro-Wilk tests indicated that questionnaire and experimental data were non-normally distributed ($\alpha = .05$); thus, non-parametric analyses (e.g., Kruskal-Wallis tests) were used in place of analyses of variance (ANOVAs) where appropriate, and data transformations were applied to improve normality when necessary. Kruskal-Wallis tests were conducted using the “Stats” package in R (R Core Team, 2021) to assess differences in stimulus valence ratings across valence groups and experimental blocks and were determined to be statistically significant, such that the positive imagery cues tended to be rated less positively than the positive pictures ($p < .001$) and neutral imagery cues tended to be rated more positively than the neutral pictures ($p < .001$). Negative imagery cues were found to be rated similarly to the negative pictures ($p = .50$). In other words, valence ratings for imagery stimuli and perception stimuli differed significantly across positive and neutral, but not negative, valence categories.

Post-hoc, within-block analyses (i.e., Dunn tests) indicated that valence categories were significantly differentiated ($p < .001$) and pairwise comparisons revealed stimuli within each valence category performed similarly to one another in both Imagery and Perception blocks ($p > .05$). Individual item and valence category descriptives for the imagery and perception stimuli are presented in Appendix A and Table 2, respectively.

Correlations

To compare the current results against previous work, initial analyses correlated participants' total BDI-II ($M = 15.98$, $SD = 11.69$) and BAI ($M = 18.61$, $SD = 13.59$) scores with vividness ratings for positive and negative imagery stimuli (Table 3; Holmes et al., 2008b; Stöber, 2000). In addition, results from a broader correlation matrix including all variables of interests are presented to provide a more comprehensive overview of variable relationships.

Depression

Initial examination of the relationship between general imagery vividness (measured via the VVIQ; $M = 15.10$, $SD = 17.99$) and depression (measured via the BDI-II) showed a small yet significant negative correlation ($r = -.17$, $p = .03$; Table 3), suggesting greater imagery vividness may be associated with *lower* scores (i.e., fewer symptoms) on the BDI-II. Further investigation into the relationship between valence-specific imagery vividness (measured via stimulus-level ratings) and depression revealed a significant negative correlation between BDI-II scores and vividness ratings for positive imagery stimuli ($r = -.20$, $p = .008$; Table 3), replicating previous findings (Holmes et al., 2008b; Stöber, 2000) and consistent with the study's hypotheses. This was accompanied by reduced (i.e., more negative) valence ratings for both positive ($r = -.17$, $p = .03$) and negative ($r = -.16$, $p = .04$) imagery stimuli, but neither positive ($r = -.12$, $p = .12$) nor negative ($r = -.05$, $p = .50$) picture stimuli, which suggests that individuals with higher BDI-II

scores experienced a more pronounced negativity bias in their valence ratings for imagined content compared to their ratings for perceptual content. In addition, and despite some literature demonstrating enhanced vividness for negative imagery in individuals with depressive features (e.g., Holmes et al., 2008b), the current study observed no such association ($r = .05, p = .53$).

Table 3

Summary Correlations for Primary Hypotheses

Disorder Scale	Vividness Variable	<i>r</i>	<i>p</i>
BDI-II	VVIQ (general)	-.17	.03 *
	Positive Vividness	-.20	.008 *
	Negative Vividness	.05	.53
BAI	VVIQ (general)	-.14 (-.002)	.08 (.77)
	Positive Vividness	-.16 (-.02)	.04 * (.77)
	Negative Vividness	.003	.96
Comorbidity Index	VVIQ (general)	-.16 (-.001)	.047 * (.99)
	Positive Vividness	-.20 (-.04)	.01 * (.57)
	Negative Vividness	.02	.78

Note. This table provides a summary of the correlation coefficients for each of the primary hypotheses. Values denoted by ‘*’ are statistically significant at $\alpha = .05$. Values in parentheses reflect the correlation coefficients and *p*-values for partial correlation results controlling for BDI-II scores.

Additional significant findings resulting from correlation analyses included negative associations between BDI-II scores and clarity ratings for positive ($r = -0.19, p = .02$) and negative ($r = -0.19, p = .02$) pictures, but not neutral pictures ($r = -0.05, p = .52$), suggesting participants with higher BDI-II scores tended to rate positive and negative pictures as less clear than neutral pictures.

Anxiety

Initial examination of the relationship between general imagery vividness (VVIQ) and anxiety (measured via the BAI) showed a small negative correlation with marginal significance ($r = -.14, p = .08$; Table 3), suggesting greater imagery vividness *may* also be associated with lower scores (i.e., fewer symptoms) on the BAI. Further, while BDI-II scores correlated in the expected direction with imagery vividness, correlation analyses revealed no significant association between participants' BAI scores and their vividness ratings for negative imagery stimuli ($r = .003, p = .96$; Table 3), which is inconsistent with previous findings (Morina et al., 2011; Pile & Lau, 2018; Stöber, 2000). Interestingly, results revealed a significant negative correlation between BAI scores and vividness ratings for positive imagery stimuli ($r = -.16, p = .04$; Table 3), which is consistent with unanticipated and unexplained findings from Morina and colleagues (2011) and Stöber (2000).

Due to a high degree of comorbidity in the current sample, partial correlations were computed between BAI scores and the VVIQ, as well as vividness ratings for positive imagery stimuli, controlling for BDI-II scores, to account for the potential influence of depressive symptoms on the observed relationships. Results showed that, after controlling for the influence of BDI-II scores, the relationship between the BAI and VVIQ ($r = -.002, p = .77$) as well as vividness ratings for positive imagery ($r = -.02, p = .77$) virtually disappeared, implicating comorbid depressive features as the primary driver of this effect.

Comorbidity

Correlations between the BDI-II and BAI revealed a strong association ($r = .71, p < .001$; Figure 2), suggesting a high degree of comorbidity within the sample. To extend previous findings from depression and anxiety as individual constructs to cases of comorbidity, the current

study also assessed associations between vividness and the extent of comorbidity, as measured by the comorbidity index. The average of participants' comorbidity index scores was calculated as $M = 415.08$, with values ranging from 45.82 to 2300. Correlations between participants' comorbidity index scores and general imagery vividness revealed a significant negative correlation ($r = -.16, p = .047$; Table 3); however, this relationship virtually disappeared after controlling for BDI-II scores ($r = -.001, p = .99$) but not BAI scores ($r = -.13, p = .09$), although marginal, suggesting this effect is primarily driven by depressive symptomatology. Vividness ratings for positive imagery stimuli also revealed a significant negative association ($r = -0.20, p = .01$; Table 3), suggesting that the extent of comorbid depressive and anxious features may be associated with reduced vividness for positive imagery. However, after controlling for the influence of BDI-II scores, the observed relationship between comorbidity and positive imagery vividness also disappeared ($r = -.04, p = .57$), supporting the earlier assertion that depressive features are the primary driver of the relationship between positive imagery and the strength of comorbidity. No relationship was observed between comorbidity index scores and vividness ratings for negative imagery ($r = .02, p = .78$; Table 3). Similar to results regarding BDI-II scores, the comorbidity index was found to be negatively associated with clarity ratings of positive pictures ($r = -.15, p = .05$) and marginally negatively associated with clarity ratings for negative pictures ($r = -.14, p = .06$). However, after controlling for BDI-II scores, these associations were virtually eliminated for both positive ($r = .007, p = .93$) and negative ($r = .06, p = .47$) pictures.

Additional correlational findings unique to comorbidity included a negative association with valence ratings for neutral imagery stimuli ($r = -.16, p = .04$) and valence ratings for

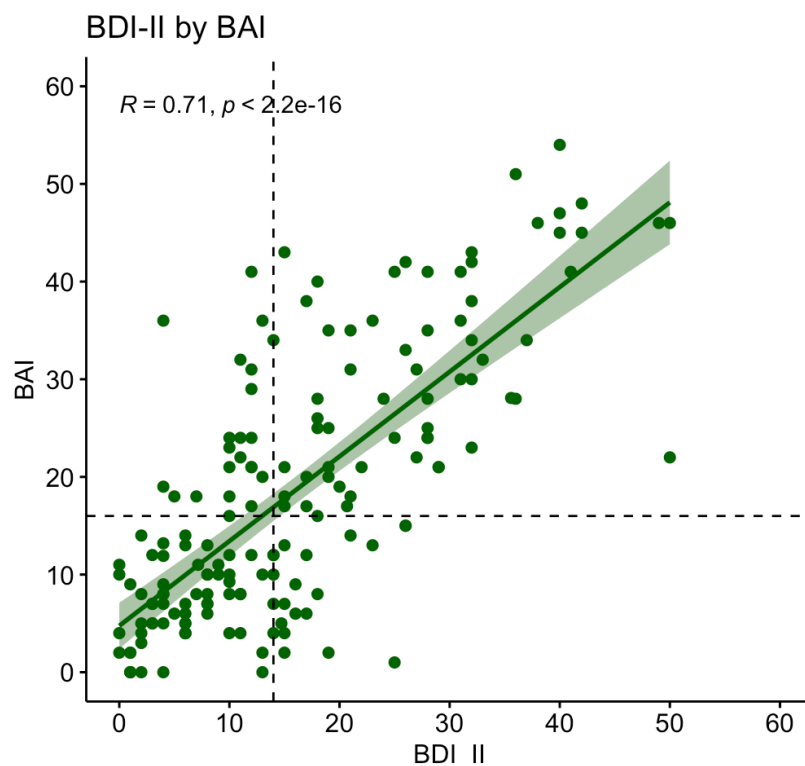
positive pictures ($r = -.15, p = .05$), potentially reflecting combined negativity bias effects associated with both depression and anxiety.

Regressions

Linear multiple regressions were conducted to test whether variables of interest were predictive of depression and anxiety, as well as for the comorbid expression of depression and anxiety, as measured by the BDI-II, BAI, and our computed comorbidity index, respectively. Given the moderate skew in the BDI-II and BAI residuals, along with the large sample size, standard linear regression analyses were considered sufficiently robust for use (Lumley et al., 2002; Tabachnick & Fidell, 2013).

Figure 2

Collinearity of BDI-II and BAI Scores



Note. This figure depicts participants' total scores on the BDI-II and BAI scales. Dashed lines indicate the median cut-offs for BDI-II (vertical; median = 14) and BAI (horizontal; median = 16).

Depression

The first regression model examined whether valenced vividness of mental imagery uniquely predicted depressive severity, as measured by BDI-II scores. The three predictors included vividness ratings for positive, negative, and neutral imagery stimuli. The overall model (Table 4) was marginally significant, $F(3,163) = 2.124$, $p = .099$, with none of the individual predictors emerging as significant ($p > 0.05$).

Table 4

Linear Multiple Regression Predicting BDI-II from Vividness

Predictor	β Estimate (std. error)	t	p
Positive Vividness	-9.56 (5.94)	-1.61	.11
Neutral Vividness	-4.74 (7.21)	-0.66	.51
Negative Vividness	7.163 (4.60)	-1.56	.12

Note. This table provides a summary of the coefficient estimates for each of the vividness variables predicting BDI-II scores. Values denoted by ‘*’ are statistically significant at $\alpha = .05$.

A second model examined whether emotional processing variables, broadly, predicted depressive features. The 12 predictors included vividness ratings of imagery (positive, negative, neutral), clarity ratings of pictures (positive, negative, neutral), and valence ratings for both Imagery and Perception blocks (positive, negative, neutral). The overall model (Table 5) was statistically significant, $F(12,154) = 2.386$, $p = .01$, and accounted for approximately 9% of the variance in BDI-II scores ($R^2 = .16$, Adjusted $R^2 = .09$). Among the predictors, valence ratings for negative imagery stimuli ($\beta = -24.17$, $t = -2.97$, $p = .004$) and clarity ratings for negative picture stimuli ($\beta = -22.59$, $t = -2.34$, $p = .02$) emerged as significant. Contrary to hypotheses, no significant effects were found for vividness ratings of positive or negative imagery stimuli.

Table 5*Linear Multiple Regression Predicting BDI-II from All 12 Variables*

Predictor	β Estimate (std. error)	<i>t</i>	<i>p</i>
Vividness (Positive Imagery)	1.96 (7.61)	0.26	.80
Vividness (Negative Imagery)	4.79 (5.12)	0.94	.35
Vividness (Neutral Imagery)	-5.91 (7.63)	-0.77	.44
Valence (Positive Imagery)	-13.89 (8.92)	-1.56	.12
Valence (Negative Imagery)	-24.17 (8.14)	-2.97	.004 *
Valence (Neutral Imagery)	-3.82 (8.52)	-0.45	.65
Clarity (Positive Pictures)	-7.15 (9.55)	-0.75	.46
Clarity (Negative Pictures)	-22.59 (9.63)	-2.34	.02 *
Clarity (Neutral Pictures)	11.30 (6.28)	1.80	.07
Valence (Positive Pictures)	-5.99 (8.71)	-0.69	.49
Valence (Negative Pictures)	-6.62 (8.72)	-0.76	.45
Valence (Neutral Pictures)	-3.71 (13.20)	-0.28	.78

Note. This table provides a summary of the coefficient estimates for each of the 12 variables predicting BDI-II scores. Values denoted by ‘*’ are statistically significant at $\alpha = .05$.

Anxiety

Models identical to those conducted for the BDI-II were run to examine the predictive capacities of the predictors on anxious features, as measured by BAI scores. Similar to BDI-II results, when including only the vividness predictors, the model (Table 6) was non-significant, $F(3,163) = 1.725$, $p = .16$, and only vividness ratings for positive imagery stimuli emerged as marginally significant ($p = .06$); however, this finding is likely explained by the collinearity observed between the BDI-II and BAI scales. When including all 12 predictors, the overall model (Table 7) was marginally significant, $F(12,154) = 1.758$, $p = .06$, accounting for

approximately 5% of the variance in BAI scores ($R^2 = .12$, Adjusted $R^2 = .05$). Among the predictors, only valence ratings for negative imagery stimuli ($\beta = -20.165$, $t = -2.09$, $p = .04$) emerged as significant. Contrary to the study's predictions, no main effects were found for vividness ratings of negative imagery.

Table 6

Linear Multiple Regression Predicting BAI from Vividness

Predictor	β Estimate (std. error)	t	p
Positive Vividness	-13.01 (6.93)	-1.88	.06 ^m
Negative Vividness	-4.86 (5.37)	0.91	.37
Neutral Vividness	-0.94 (8.41)	-0.11	.91

Note. This table provides a summary of the coefficient estimates for each of the vividness variables predicting BAI scores. Values denoted by '*' are statistically significant at $\alpha = .05$. Values denoted by 'm' are marginally significant.

Comorbidity

The same models were used to examine whether the same predictors predicted participants' comorbidity index, as measured by the product of their BDI-II and BAI scores. Since initial analyses revealed comorbidity index residuals to be highly skewed, these scores were square-root-transformed to account for the potential impact of non-normality on the following regressions. When including only the vividness predictors, the model (Table 8) was non-significant, $F(3,163) = 2.09$, $p = .10$. When including all 12 predictors, the overall model (Table 9) was statistically significant, $F(12,154) = 2.09$, $p = .02$, accounting for approximately 7% of variation in comorbidity index scores. Among the predictors, only valence ratings for negative imagery stimuli ($\beta = -21.93$, $t = -2.59$, $p = .01$) and clarity ratings for negative picture

stimuli ($\beta = -21.16$, $t = -2.11$, $p = .04$) emerged as significant. No significant effects were found for any of the valenced vividness ratings in either model.

Table 7

Linear Multiple Regression Predicting BAI from All 12 Variables

Predictor	β Estimate (std. error)	t	p
Vividness (Positive Imagery)	-6.77 (9.03)	-0.75	.45
Vividness (Negative Imagery)	1.92 (6.08)	0.32	.75
Vividness (Neutral Imagery)	0.09 (9.06)	0.01	.99
Valence (Positive Imagery)	-4.29 (10.60)	-0.40	.69
Valence (Negative Imagery)	-20.17 (9.67)	-2.09	.04 *
Valence (Neutral Imagery)	-16.45 (10.12)	-1.63	.11
Clarity (Positive Pictures)	6.08 (11.34)	0.54	.59
Clarity (Negative Pictures)	-20.28 (11.44)	-1.77	.08
Clarity (Neutral Pictures)	7.40 (7.45)	0.99	.32
Valence (Positive Pictures)	-12.99 (10.34)	-1.26	.21
Valence (Negative Pictures)	-15.03 (10.35)	-1.45	.15
Valence (Neutral Pictures)	-12.07 (15.67)	-0.77	.44

Note. This table provides a summary of the coefficient estimates for each of the 12 variables predicting BAI scores. Values denoted by ‘*’ are statistically significant at $\alpha = .05$.

Table 8

Linear Multiple Regression Predicting Comorbidity from Vividness

Predictor	β Estimate (std. error)	t	p
Positive Vividness	-11.75 (6.11)	-1.92	.06
Negative Vividness	5.62 (4.73)	1.19	.24
Neutral Vividness	-2.39 (7.42)	-0.32	.75

Note. This table provides a summary of the coefficient estimates for each of the vividness variables predicting comorbidity index scores(square-root-transformed). Values denoted by ‘*’ are statistically significant at $\alpha = .05$.

Table 9

Linear Multiple Regression Predicting Comorbidity from All 12 Variables

Predictor	β Estimate (std. error)	t	p
Vividness (Positive Imagery)	−3.24 (7.90)	−0.41	.68
Vividness (Negative Imagery)	3.01 (5.32)	0.57	.57
Vividness (Neutral Imagery)	−2.66 (7.92)	−0.34	.74
Valence (Positive Imagery)	−8.75 (9.27)	−0.94	.35
Valence (Negative Imagery)	−21.93 (8.46)	−2.59	.01 *
Valence (Neutral Imagery)	−9.60 (8.85)	−1.08	.28
Clarity (Positive Pictures)	0.54 (9.92)	0.06	.96
Clarity (Negative Pictures)	−21.16 (10.01)	−2.11	.04 *
Clarity (Neutral Pictures)	8.96 (6.52)	1.38	.17
Valence (Positive Pictures)	−10.62 (9.05)	−1.17	.24
Valence (Negative Pictures)	−11.93 (9.06)	−1.32	.19
Valence (Neutral Pictures)	−7.98 (13.71)	−0.58	.56

Note. This table provides a summary of the coefficient estimates for each of the 12 variables predicting comorbidity index scores. Values denoted by ‘*’ are statistically significant at $\alpha = .05$.

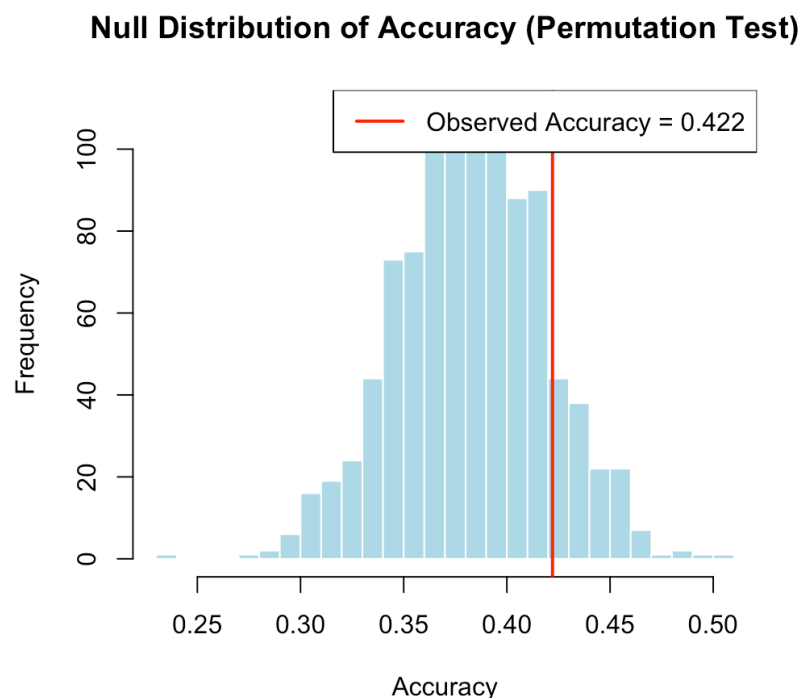
Classifications

To further address the study’s hypotheses, a Naïve Bayes classification analysis was conducted to assess whether participants could be accurately classified into one of four severity groups (i.e., *low-low*, *high-low*, *low-high*, or *high-high*) based on their vividness ratings of imagery stimuli. Groups were defined based on participants’ total BDI-II and BAI scores, such that those with low scores (i.e., below the median) on both scales were categorized as the *low-*

low group, those with high scores (i.e., above the median) on only the BDI-II were categorized as *high-low*, those with high scores on only the BAI were categorized as *low-high*, and those scoring high on both scales were categorized as *high-high*. The model employed an 8-fold cross validation and a permutation test ($n = 1000$) to assess efficacy. Observed effects were compared to a null distribution of accuracies (Figure 3) generated through permutation testing. The current classifier achieved an observed accuracy of 44.2%, suggesting that valenced vividness ratings alone were able to classify participants into severity groups beyond chance (25%); however, the model was unable to achieve an ideal level of statistical significance ($p = .13$).

Figure 3

Null Distribution of Accuracy Based on Vividness

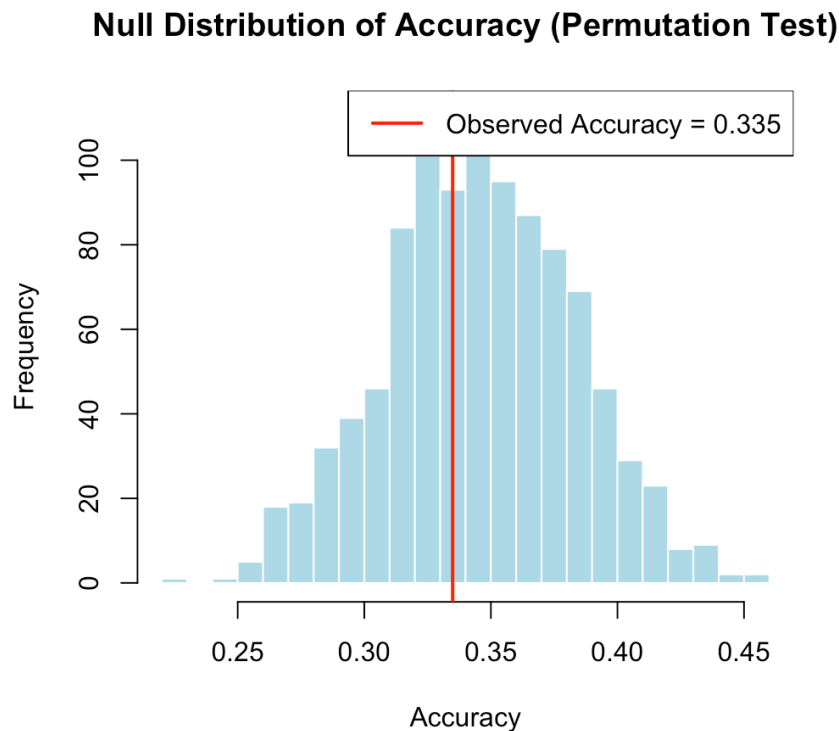


Note. This figure depicts the null distribution of classification accuracy generated via permutation testing, representing model performance expected by chance. The vertical red line indicates the actual observed accuracy relative to the null distribution. This model is based only on the vividness ratings for positive, negative, and neutral imagery.

An additional classifier was modeled under the same parameters but included valence and vividness/clarity ratings for both imagery and picture stimuli to assess whether participants could be more accurately and consistently classified into one of the four groups when considering all variables of interest simultaneously. Observed effects were compared to a null distribution of accuracies (Figure 4) generated through permutation testing. This classifier achieved an observed accuracy of 33.5%, and did not reach statistical significance ($p = .61$), indicating an inability to classify participants based on all 12 relevant variables simultaneously.

Figure 4

Null Distribution of Accuracy Based on All 12 Predictors



Note. This figure depicts the null distribution of classification accuracy generated via permutation testing. The vertical red line indicates the actual observed accuracy relative to the null distribution. This model is based on all 12 predictor variables (i.e., vividness and clarity ratings for each valence category and valence ratings for each experimental block).

Discussion

The present study sought to investigate the relationship between internally and externally generated visual-affective features and psychopathology. Utilizing an emotion appraisal task that included both internally generated (i.e., imagery) and externally presented (i.e., perceptual) emotional stimuli, participants provided ratings of valence and vividness/clarity for each trial. These trial-level metrics were compared with self-report measures of symptom severity for depression and anxiety, as well as an index of comorbidity, to assess valence- and disorder-specific differences in the vividness of participants' mental imagery, explore the differences between the evaluation and appraisal of internally and externally generated visual content, and to compare the contribution of unidimensional and multidimensional models on observed effects. Overall, the study partially replicated previous findings regarding valence-specific imagery differences associated with depression (Holmes et al., 2008b; Morina et al., 2011; Pile & Lau, 2018; Stöber, 2000) and provided evidence for distinct patterns in the processing of internal and external visual stimuli related to depressive severity. Additionally, the results suggest that dimensional approaches (i.e., regression) to modeling disorder severity may offer stronger predictive utility than multidimensional categorical (i.e., classification) modeling.

Consistent with previous work (e.g., Holmes et al., 2008b, Stöber, 2000), depressive symptoms were negatively associated with vividness ratings for positive imagery, indicating that individuals with higher levels of depressive features experienced difficulty generating positive imagery. Similarly, initial results demonstrated reduced vividness for positive imagery associated with anxiety. While other studies have observed similar results (Morina et al., 2011; Stöber, 2000), they have included significant overlap between their measures of depression and anxiety. Indeed, our findings show that depressive features consistently emerged as the primary driver of

this effect. Contrary to prior studies, there was no significant relationship between vividness of negative imagery and depressive features (as seen in Holmes et al., 2008b and Pile & Lau, 2018) and no expected enhancement of negative imagery vividness in anxiety (as seen in Morina et al., 2011, Pile & Lau, 2018, and Stöber, 2000).

Moreover, linear multiple regression models incorporating vividness for valenced imagery as the sole predictors failed to significantly predict symptom severity, whereas models that included a combination of vividness, valence, and clarity ratings across both imagery and perception stimuli significantly predicted scores on the BDI-II, BAI, and comorbidity index, separately. This finding suggests that imagery impairments alone are insufficient to accurately predict symptom severity; rather, a combination of distinct imagery and perceptual factors ought to be considered when predicting dimensional constructs. Importantly, classification models that leveraged a multidimensional outcome variable were unable to categorically classify participants into groups based on their combination of symptom severity levels (i.e., high vs. low) for depression and anxiety. That regression modeling – predicting symptom severity on a single continuous severity dimension – was successful, and classification modeling – predicting discrete psychopathological categories from multidimensional data – unsuccessful, suggests that disorder-related effects may be better captured along a single dimensional continuum rather than categorical thresholds. Such a finding is consistent with contemporary dimensional models of psychopathology (Insel et al., 2010; Kotov et al., 2017) and questions the utility of the BDI-II and BAI as categorical versus dimensional measures of symptom severity.

Valence-Specific Impairments in Imagery

One of the most robust findings in this study was the observation that individuals with higher depressive symptomatology tended to report reduced vividness for positive imagery.

Although the temporal direction of this effect remains uncertain, this finding aligns with previous literature demonstrating impairments in the ability to generate and maintain positive internal representations in individuals with depressive/dysphoric features (Holmes et al., 2008b; Morina et al., 2011; Pile & Lau, 2018; Stöber, 2000). Reduced capacity for generating positive emotional content is also consistent with neuroimaging research on depressive disorders (Hach et al., 2014; Jaworska et al., 2015; Mantani et al., 2005). For instance, work specific to mental imagery has suggested patterns of hypoactivity in response to positive imagery in individuals reporting symptoms of depression, particularly in the PCC (Mantani et al., 2005) – implicated in internal (i.e., episodic retrieval, self-referential cognition) attentional processes (Foster et al., 2023) – as well as the hippocampus, precuneus, and cuneus – implicated in visual imagery and episodic richness (Hach et al., 2014). Reduced activity of these regions, accompanied by heightened activity of frontal control networks (Hach et al., 2014), suggests that individuals with depressive symptoms may rely more heavily on top-down, effortful cognitive processes to support imagery generation in order to compensate for under-activation of regions typically responsible for vivid internal representations (e.g., PCC; Mantani et al., 2005; hippocampus, precuneus, and cuneus; Hach et al., 2014). This compensatory recruitment of frontal regions may reflect greater cognitive load or increased focus during imagery tasks, which could, in turn, limit the vividness of imagined positive content. Taken together, these findings suggest not only that the capacity to generate positive imagery is diminished in depression, but that the neural systems typically engaged in this process may be functionally disrupted, contributing to broader difficulties in emotional experience. Indeed, our study also found that depression scores were associated with more negative valence ratings for positive imagery but not positive perceptual stimuli, indicating

a dissociation between the way positive internal and external visual content is processed and evaluated in depression.

Reduced vividness for positive imagery in depression is also consistent with literature on attentional biases. Robust evidence exists which demonstrates attentional biases away from positive stimuli associated with depression (Sears et al., 2010; Suslow et al., 2020; Winer & Salem, 2016). Such biases may limit the extent to which individuals with depressive symptoms engage with or sustain attention on emotionally positive content, thus diminishing their ability to encode and retrieve positive information from memory for the purposes of generating vivid imagery (Greenberg & Knowlton, 2014). Collectively, attentional avoidance of positive stimuli and neural inefficiency in imagery-related brain regions may contribute to the impoverished experienced of positive imagery observed in depression.

Furthermore, depressive severity was found to be associated with lower scores on a standardized measure of general imagery vividness (i.e., the VVIQ). Importantly, items on the VVIQ are primarily comprised of prompts that are objectively positive; for example, the VVIQ asks responders to imagine a close friend or relative, frequented shops, and serene scenery (e.g., mountains, lakes, etc.). Thus, the notion of specific impairments in generating vivid positive imagery in individuals with greater depressive severity is further supported by corresponding evidence from a more standardized self-report measure of imagery vividness.

Notably, the current study did not find an association between depressive nor anxious symptomatology and the vividness of negative imagery, which is inconsistent with previous studies (Holmes et al., 2008b; Morina et al., 2011; Pile & Lau, 2018; Stöber, 2000) as well as attention literature showing biases toward negative information in both disorders (e.g., Bradley et al., 1997; Caseras et al., 2007; Matthews & Antez, 1992; Pergamin-Hight et al., 2015; Veerapa et

al., 2020). One possibility is that increased attention to emotional stimuli does not necessarily increase imagery vividness, particularly if emotional blunting (e.g., alexithymia; difficulty identifying, understanding, and expressing emotion) or disengagement processes (e.g., attentional avoidance) are at play. For example, previous research has shown that individuals with high levels of alexithymia reported reduced vividness for both happy and sad imagery content compared to individuals with low levels (Mantani et al., 2015), suggesting that general emotional blunting may have disrupted imagery processes. For depression, such an effect may have explained our finding of reduced vividness for positive imagery; however, it cannot explain the lack of relationship with vividness for negative imagery in the current sample. Further, the literature on attentional processes in depression does not suggest tendencies for attentional avoidance of negative stimuli (Blicher et al., 2020; Bradley et al., 1997; Caseras et al., 2007; Matthews & Antes, 1992; Sanchez et al., 2013) and that of anxiety is heavily mixed, with some research demonstrating biases toward negative stimuli (Becker et al., 2001; Mogg et al., 1995; Veerapa et al., 2020) and others demonstrating attentional avoidance of emotional stimuli altogether (Chen et al., 2012; Garner et al., 2006; Gotlib et al., 2004; Monk et al., 2006). Even so, there is no evidence to suggest that attentional biases characteristic of mood and anxiety disorders extend to or influence the generation and vividness of mental imagery in such cases.

An alternate explanation for the lack of association between psychopathological features and negative imagery vividness can be found in differences in stimulus design. Most notably, imagery stimuli in previous studies were primarily *prospective* in nature, in that participants were asked to imagine *future* events (Holmes et al., 2008b; Morina et al., 2011; Pile & Lau, 2018; Stöber, 2000), rather than imagining events as if they were occurring in real time, as in the current study. Thus, it is possible that disorder effects on negative imagery vividness may be

specific to prospective imagination, with our observation of reduced vividness for positive imagery instead reflecting broader deficits in reward processing, commonly associated with depression (e.g., Rolls, 2016; Rolls et al., 2020), regardless of temporal framing.

The role of comorbid depression and anxiety presents an important consideration when interpreting results of the two disorders separately; however, because the current study did not observe vividness effects independent of depressive symptomatology, it remains unclear whether depressive features exert a dominant influence on internal representations or whether potential additive effects of comorbid depression and anxiety might have been present but undetectable in the current sample. Nonetheless, existing literature suggests that comorbid depression and anxiety are often associated with distinct neural (Engels et al., 2010; Hamilton et al., 2015; Sindermann et al., 2022), cognitive (Crane et al., 2016; Queen & Ehrenreich-May, 2014), and attentional (LeMoult & Joormann, 2012; Markela-Lerenc et al., 2011) patterns compared to either disorder alone, and thus could be further associated with differential impact on other cognitive processes, such as mental imagery. As the present findings were found to be driven by depressive symptomatology and no vividness effects independent of depression emerged, inferences can only be made about depression in relation to imagery vividness. Future studies should aim to examine the interactive and potentially unique effects of comorbidity on internal representations.

Divergence in Valence Appraisals

Another notable finding from the current study was the divergence in valence ratings for emotional stimuli between imagery and perception blocks. Including both an imagery and perception task provided a unique opportunity to examine how visual emotional content is processed depending on its generation (internal vs external sources). It was found that higher

scores on the BDI-II were associated with more negative valence ratings for both positive and negative *imagery stimuli*, but neither positive nor negative *picture stimuli*, indicating a more pronounced negativity bias in valence appraisals for internally generated emotional content compared to externally perceived emotional content. Such a finding suggests that the appraisal of internally generated experiences is uniquely affected by emotional biases characteristic of depression. In other words, for individuals with greater depressive severity, visual imagery may carry either greater emotional weight or increased susceptibility to negative mood states than externally observed information. Indeed, previous research has observed that individuals with depression experience higher levels of emotional distress as a result of their imagery compared to controls, suggesting that individuals with depressive disorders are uniquely impacted by their imagery experience (Görge et al., 2015; Newby & Moulds, 2011); however, to the best of our knowledge, the current study is the first to directly compare valence appraisals of internal and external visual content.

A possible explanation for the heightened negativity in imagery-based valence appraisals among individuals with greater depressive severity is the inherently self-referential nature of imagery. Not only is spontaneous mental imagery typically engaged using self-referent perspectives (D'Argembeau, 2020), but the imagery trials in this study were prompted using cues framed in the second person (e.g., "You are cooking dinner."), which may have encouraged participants to adopt a more personally involved and, therefore, affectively engaged perspective during their imagery. In contrast, the perceptual stimuli – standardized emotional images drawn from the OASIS database (Kurdi et al., 2017) – were not self-referential and depicted emotionally salient scenes from a third-person perspective. This difference in stimulus framing may have amplified the emotional impact of internally generated content, particularly for

individuals with depressive disorders, who are more prone to self-focused (Ingram, 1990; McIvor et al., 2021; Nolen-Hoeksema, 2000) and negatively biased processing (Collins & Winer, 2024). Indeed, self-referential processing has been shown to recruit distinct neural networks (e.g., medial orbital, ventromedial, and dorsomedial prefrontal cortices; for a meta-analysis, see Northoff et al., 2006) and to intensify emotional responses (N'Diaye et al., 2009; Zhang et al., 2020). Therefore, the stronger association between depressive symptoms and negative valence ratings for imagery, but not pictures, may reflect the enhanced emotional reactivity elicited by imagining oneself within emotionally valenced scenarios, further supporting the notion that depression may disproportionately affect the subjective evaluation of internal experiences. Moreover, negative self-referential processing, as opposed to positive, has been shown to impair performance on cognitive tasks (Kim et al., 2022). If such processing demands greater cognitive resources, this may reduce the availability of resources supporting other functions, such as imagery generation. This, in turn, may partially explain the lack of observed association between measures of psychopathology and negative imagery vividness in the current study. Together, these findings highlight the importance of considering not just stimulus valence, but also perspective-taking and self-relevance, when evaluating how internal and external emotional content is appraised in the context of depression.

Alterations in Subjective Perceptual Clarity

Intriguingly, the current study found that higher BDI-II scores were associated with reduced clarity ratings for both positive and negative picture stimuli, but not for neutral pictures. This pattern suggests that individuals with greater depressive symptomatology subjectively perceived emotional pictures as less perceptually clear. Such a finding may reflect broader disruptions in how visual information is processed in depression, particularly when that

information carries emotional weight. Prior research has demonstrated alterations in early-stage visual processing in MDD, even in response to emotionally neutral stimuli (e.g., Gabor gratings), with reduced contrast sensitivity and impaired retinal and cortical responses observed in depressed individuals compared to controls (Bubl et al., 2009; Bubl et al., 2010; Bubl et al., 2015). Similarly, Valt and colleagues (2022) reported diminished early visual responses – as indicated by smaller vertex positive potentials (VPPs) – in individuals with MDD across both active and passive viewing conditions. Notably, these effects occurred across different stimulus categories (e.g., faces and houses), suggesting a generalized reduction in external visual processing rather than a content-specific deficit.

In light of these findings, the current observation of reduced clarity for emotional, but not neutral, pictures may suggest a compounding effect. Not only is visual processing broadly attenuated in depression (Bubl et al., 2009; Bubl et al., 2010; Bubl et al., 2015), but emotional stimuli may place additional demands on perceptual and affective systems that are already compromised (Atchley et al., 2012; Bylsma, 2021). The processing of emotional pictures requires both the recognition of visual features (e.g., shape, size, colour) and the appraisal of affective meaning – two distinct but interactive processes (Pessoa, 2009, 2010; Zadra & Clore, 2011). The integration of these perceptual and emotional components is cognitively demanding and relies on the coordination of both sensory and affective networks (e.g., Liu et al., 2021). If depressive symptomatology disrupts either or both of these systems, then the combined processing of emotional visual content may be particularly vulnerable to dysfunction. This vulnerability may be heightened by the tendency of individuals with depression to engage in increased self-focus (Ingram, 1990; Nolen-Hoeksema, 2000; McIvor et al., 2020), which may divert cognitive resources away from sensory processing. Thus, while prior studies have shown

impairments in visual and emotional processing independently, the present findings suggest that depression may further impair the integration of these processes, leading to a subjective experience of emotional images as less perceptually clear.

Dimensional vs. Multidimensional Approaches

While prior research has focused on interoceptive visual distortions, the current study aimed to examine the combined predictive power of internal and external variables in relation to both continuous/dimensional and categorical/multidimensional analytic strategies. A key finding was that linear multiple regression models using imagery vividness alone failed to significantly predict symptom severity, whereas models incorporating a combination of vividness, valence, and clarity ratings across both imagery and perception tasks successfully predicted BDI-II, BAI, and comorbidity scores. In contrast, classification models attempting to categorize and differentiate participants based on high and low symptom thresholds were unsuccessful with either set of predictive features, even when leveraging the multidimensional outcome variables.

The failure of vividness scores alone to significantly predict depression or anxiety symptoms suggests that impairments in vividness, while clinically relevant (e.g., Kumari & Patil, 2023; Pile et al., 2021), do not meaningfully account for symptom variation in depressive, anxious, and comorbid contexts. Instead, the integration of multiple features – such as vividness/clarity and valence appraisal – across both intero- and exteroceptive modalities, may provide a more complete and nuanced understanding of how emotional processing deviates in psychopathology. That valence and perceptual clarity ratings added predictive power beyond vividness further supports the argument that subjective emotional and perceptual evaluations are critical to understanding affective symptoms (Klein & Robinson, 2021). It also implies that

interventions targeting imagery alone may be insufficient without also addressing distortions in affective evaluations and perceptual processing.

The differential success of the analytic strategies used in this study further highlights the importance of aligning methodological approaches with the underlying structure of psychological phenomena. Linear multiple regression models, which treated depression and anxiety as continuous, dimensional constructs, captured meaningful symptom severity variation. In contrast, classification models that attempted to predict categorical groupings defined by multidimensional symptom severity (e.g., high-depression/low-anxiety, low-depression/high-anxiety) failed to classify individuals reliably. This suggests that while the underlying processes may be multidimensional in nature, modeling them using rigid categorical groupings may obscure meaningful variability. Even when both predictors and outcomes were multidimensional, classification models did not outperform dimensional regression approaches.

This pattern of results aligns with contemporary dimensional frameworks such as the Research Domain Criteria (RDoC; Insel et al., 2010) and the Hierarchical Taxonomy of Psychopathology (HiTOP; Kotov et al., 2017), which conceptualize mental disorders as existing along various continuums rather than within discrete categories. The current data suggest that emotional and perceptual disruptions may be better understood as varying by degree rather than category, and that subtle gradations in symptom severity are better captured through dimensional modeling. Moreover, the failure of the classification models to detect distinct comorbidity profiles underscores a broader limitation of traditional diagnostic systems, which may impose artificial boundaries on symptom clusters that are, in reality, more fluid and overlapping.

These findings reinforce the need to conceptualize depression and anxiety not just as co-occurring disorders, but as intersecting syndromes with shared and distinct cognitive-affective

features that manifest along spectrums. Dimensional modeling appears better suited to detect these patterns, offering greater precision and sensitivity than categorical approaches. From a clinical perspective, this calls for greater flexibility in diagnosis and treatment planning. If individuals cannot be reliably grouped based on categorical symptom thresholds, then treatments targeting disorder-specific labels may miss transdiagnostic or individual patterns of dysfunctions. Moreover, removing rigid categorical distinctions may help reduce stigma as it shifts away from a binary “has” or “has not” model of pathology (Lahey, 2021). Adopting dimensional, data-driven approaches may allow for more accurate identification of treatment targets and more nuanced clinical formulations.

Implications for Theoretical Models and Clinical Practice

The current findings contribute to existing theoretical models of depression, particularly those emphasizing impairments in positive emotion processing. The observation that individuals with greater depressive severity reported reduced vividness for positive imagery supports models of depression that emphasize deficits in reward processing (Roll, 2013; Rolls et al., 2022), as well as attenuation of emotional reactivity to (Rottenberg & Gotlib, 2005) and attentional disengagement from (Chen et al., 2012; Garner et al., 2006; Gotlib et al., 2004; Monk et al., 2006) positive stimuli. Neuroimaging evidence from prior work has shown corresponding hypoactivity in regions associated with visual imagery and episodic memory (Hach et al., 2014; Mantani et al., 2005) paired with increased recruitment of frontal control areas (Hach et al., 2014), suggesting that individuals with depression may rely more heavily on top-down effortful processing to simulate positive imagery. Importantly, the lack of association between symptom severity and negative imagery vividness complicates existing assumptions about attentional biases in depressive disorders (Bradley et al., 1997; Caseras et al., 2007; Matthews & Antes,

1992) and anxiety (Becker et al., 2001; Mogg et al., 1995; Veerapa et al., 2020). Despite prior findings of attentional bias toward negative material, the current findings suggest that attentional biases alone may be insufficient to influence the vividness of mental imagery. This implies that cognitive biases – such as interpretive or memory-related biases – may also play a role in shaping the quality of internally generated affective content. These results help refine existing cognitive models by highlighting the need to distinguish between attentional orientation and the quality of affective imagery.

Clinically, findings of positive imagery impairments in depression underline the need to address both the quality and accessibility of positive internal representations in therapeutic contexts. Interventions that rely on the use of mental imagery – such as imagery rescripting (Pile et al., 2021) and mindfulness-based guided imagery (Kumari & Patil, 2023) – may benefit from explicitly targeting the vividness and affective tone of imagined content. If individuals with depression struggle to vividly generate positive internal experiences, they may also have difficulty accessing cognitive resources that could serve to regulate mood or motivate adaptive behaviour and cognitions. Further, the unresolved role of comorbidity in these processes highlights the need for future research to explore how comorbid profiles shape internal representations, particularly given evidence that combined symptom presentations may involve distinct cognitive and neural processes not fully captured by examining depression or anxiety in isolation.

The current findings also offer important insights into the cognitive-affective architecture of depression, particularly regarding how emotional information is processed depending on its source modality. The stronger association between depressive symptom severity and negative valence ratings for imagery, but not perceptual stimuli, suggests that internally generated

cognitions may be more susceptible to depressive appraisal biases than external visual representations. This supports appraisal-based models of depression, which emphasize that emotional dysfunction stems from biased affective interpretations of one's environment (Mehu & Scherer, 2015; Rolls, 2013; Scherer et al., 2022), particularly when those interpretations stem from self-referential and internally generated content. However, that responses to neutral stimuli did not exhibit negative appraisal biases is counter to previous studies demonstrating such effects for ambiguous stimuli (for a meta-analysis, see Everaert et al., 2017). That negative appraisal biases were specific to emotional imagery, but not neutral, further implies that affective content may play a critical role in triggering distorted appraisals, reinforcing the idea that depression may involve an over-engagement with internally constructed emotional meaning. These findings also point to a potential dissociation between the vividness of mental imagery and its emotional impact. That is, a key distinction can likely be made between *visual* vividness, as assessed in subjective vividness ratings, and *emotional* vividness, as may be approximated by subjective valence ratings. Thus, even in the absence of heightened visual vividness, imagery in depression may exert stronger emotional vividness, underscoring the need to consider both the visual and affective dimensions of imagery, as well as their interaction, in future research. Importantly, this also highlights the value of examining how these components independently contribute to emotional dysregulation in depression.

Findings of more negative appraisals for emotional imagery but not perceptual content also underscore the need for therapeutic approaches that address not only the content of internal visual experiences, but also the perspective from which they are generated and evaluated. For instance, interventions that aim to reduce maladaptive self-referential processing – such as mindfulness-based cognitive therapy (Lin et al., 2018; Stalmeier et al., 2022) – may help weaken

the emotional salience of distressing internal imagery. Similarly, therapies that specifically target biased appraisal of mental images, such as imagery rescripting (Pile et al., 2021), may offer benefit by modifying the emotional tone of internally generated experiences without necessarily enhancing their visual vividness. That depressive symptoms were linked to more negative appraisals of both positive and negative imagery also raises important questions about the capacity for positive imagery to serve a mood-regulatory function in depression – a commonly used technique in imagery-based interventions (Pile et al., 2021; Kumari & Patil, 2023). The current findings suggest that even positive imagery may be interpreted through a negatively biased lens in those with greater depressive severity, potentially limiting its therapeutic value.

Furthermore, the observed divergence between intero- and exteroceptive processing supports the idea that depression is not simply characterized by negative emotional content, but by the manner in which emotional information is processed. The heightened negativity of internal visual appraisals, paired with diminished perceptual clarity of external affective stimuli, suggests that individuals with depressive symptoms may be more vulnerable to the emotional impact of imagined or self-generated experiences than to those grounded in external reality. This imbalance may perpetuate a feedback loop in which distorted internal experiences dominate emotional life, while potentially mood-corrective input from the external world is emotionally and perceptually downregulated. This is consistent not only with the biased competition model of visual processing (Desimone & Duncan, 1995), but also appraisal bias models of depression and broader psychopathology, which propose that emotional dysfunction arises not simply from the presence of negative stimuli, but from rigid and systematic distortions in how such stimuli are interpreted and evaluated (Mehu & Scherer, 2015). Such a mechanism may help to explain why

individuals with depression often disengage from rewarding or emotionally salient aspects of their environment and instead become entrenched in internally focused, ruminative thinking.

These findings may also have broader implications for how depression is conceptualized. Rather than viewing depressive symptomatology solely in terms of negative affect or low mood, the results highlight the importance of considering how cognitive, affective, *and* perceptual processes interact across different sources of emotional information. Depression may thus be better understood as involving not just heightened sensitivity to negative internal content, but also a relative alteration of perceptual and emotional responsiveness to the external environment. This dual disruption suggests that effective interventions may need to target both internal interpretive biases and the perceptual disengagement from emotionally meaningful external experiences.

Indeed, therapeutic approaches that encourage re-engagement with external experiences – such as behavioural activation (Filip & Carter, 2024) – may help counteract perceptual disengagement from emotionally meaningful stimuli. Additionally, interventions that address the interpretation and emotional appraisal of internally generated imagery, such as imagery rescripting (Pile et al., 2021) or cognitive restructuring techniques (Ezawa & Hollon, 2023), may be particularly valuable for individuals whose internal emotional experiences are especially distressing. Future research should continue to investigate how these internal–external processing dynamics develop and change over time and whether they respond differentially to various treatment modalities. Understanding this imbalance may offer new insights into the maintenance of depressive states and highlight novel targets for therapeutic intervention.

Limitations and Future Directions

While the current study offers important insights into the nature of mental imagery and its relation to depression and anxiety, a number of limitations should be considered when interpreting the findings.

The cross-sectional design, analyzing data from a single point in time, precludes causal inferences. Although the observed associations between depressive symptom severity and deficits in positive imagery suggest a possible contribution of imagery impairments in emotional dysfunction, the temporal direction of this relationship remains unclear. Appraisal-based models of psychopathology would argue that biases in internal representations and interpretations may play a formative role in the onset and maintenance of depression (Mehu & Scherer, 2015; Rolls, 2013; Scherer et al., 2022). However, in disorders such as PTSD, the emergence of dysfunctional imagery – in the form of flashbacks – often marks the onset of disorder (Brewin, 2015; Wang et al., 2019), suggesting that vivid and intrusive mental representations may be a consequence rather than a cause. It is also possible that the causal relationship between imagery and emotional dysfunction may vary across diagnostic categories or even fluctuate within individuals over time. Longitudinal designs will be critical for determining whether impaired imagery acts as a predisposing vulnerability, a maintenance mechanism, or a symptom-level outcome of psychopathology.

In addition, the generalizability of the present findings is limited by the sample characteristics. The study relied on a sample drawn from a university population, which was inherently homogenous and predominantly female, limiting the extent to which generalizations can be made to more diverse populations. Relatedly, the classification models used to explore multidimensional symptom profiles were limited in several ways. First, the use of median splits

to create categorical groupings of high and low symptom severity was constrained by unequal severity thresholds: median BDI-II scores represented the beginning of the “mild” range, while BAI scores represented the beginning of the “moderate” range. This inconsistency may have undermined the interpretability of the groupings and the sensitivity of the classification models. Moreover, the resulting group sizes were also unequal, with the majority of the sample reporting high severity (as determined by median cut-offs) in both depressive and anxious symptoms, and a much smaller number of participants reporting high-depressive/low-anxious and low-depressive/high-anxious features, which may have interfered with the ability to detect group differences and classify participants accordingly. While the present sample allowed for the investigation of symptom dimensions, it did not control for clinical or subclinical presentations. In other words, the current sample likely included a mixture of participants who did and did not meet diagnostic criteria for depression and/or anxiety; thus, it may not reflect the full spectrum of cognitive-affective dysfunction that may have been observed in a sample containing exclusively clinically diagnosed individuals. However, given that the BDI-II (min = 0; max = 50) and BAI (min = 0; max = 54) scores in the current sample spanned a wide range of severity, it is likely that meaningful variation was captured. Still, future work may benefit from explicitly controlling for diagnostic status or recruiting clinical populations to ensure comprehensive coverage and facilitate interpretation.

Additionally, given that depressive features dominated the observed effects, classification strategies that attempted to distinguish comorbid groups based on both depression and anxiety symptomatology may have been confounded. While the intention was to assess whether specific combinations of severity could be predicted from variables of interest, the absence of distinct anxiety effects means that classification models may have been overly influenced by the

depression dimension alone. However, since contemporary frameworks suggest dimensional approaches to be more sensitive to individual variability (Insel et al., 2010; Kotov et al., 2017), it is unlikely that classification (i.e., categorical) modeling would have been successful, even in the presence of anxiety effects. Nonetheless, the inability to reliably classify participants by comorbidity profiles highlights the complexity of symptom overlap and reinforces the value of dimensional modeling for capturing within-group variability.

Another important consideration when interpreting the current results is the nature of the stimuli and assessment measures used in the study. Mental imagery is inherently self-referential (D'Argembeau, 2020), and the cues used to elicit imagery in this study were presented in the second person, encouraging a first-person perspective. In contrast, the perceptual stimuli were drawn from the standardized OASIS database (Kurdi et al., 2017) and presented emotionally salient but non-self-referential visual scenes. This difference in framing may have influenced both the emotional appraisal (Zhang et al., 2020) and cognitive engagement (Kim et al., 2022) with the stimuli, complicating direct comparisons between internally generated and externally perceived content. The heightened emotional reactivity to imagery trials may, in part, reflect the personal relevance and perspective-taking required by the task design, rather than differences inherent to internal versus external processing. However, if internal visual processing inherently elicits a self-referential perspective (D'Argembeau, 2020), then this tendency itself may reflect a key mechanism of differentiation between internal and external visual processing. Future research should aim to equate or systematically manipulate stimulus framing to better isolate modality effects from self-referential processing. Moreover, the study relied entirely on self-report measures to assess both symptom severity and trial-level outcomes (i.e., vividness, valence, and clarity), introducing potential subjectivity and response bias. While subjective

ratings are valuable for capturing internal experience, they may be influenced by factors such as mood-congruent recall, demand characteristics, or limited insight into one's own cognitive processes. To validate and extend these findings, future research should incorporate more objective methods of assessment. For instance, eye tracking has been shown to reflect attentional allocation during mental imagery (Laeng et al., 2014), while psychophysiological measures (e.g., electrodermal activity) can offer indices of emotional arousal in response to imagery (Wicken et al., 2021). Neuroimaging approaches may also help clarify the neural substrates supporting distinct imagery processes in their disruptions in mood and anxiety disorders.

Conclusions

The present study examined how internal and external visual representations relate to depressive and anxious symptomatology by comparing participants' appraisals of imagery and perceptual stimuli. The findings offer several key insights into the nature of emotional processing in depression. Most notably, depressive symptoms were associated with reduced vividness of positive imagery, reinforcing prior evidence that individuals with depression struggle to generate visually rich positive internal representations. This impairment may reflect disruptions in neural systems supporting visual imagery and reward processing, as well as attentional disengagement from emotionally positive information.

In addition, the study did not replicate previous findings linking depression or anxiety with enhanced vividness of negative imagery. This absence of association suggests that increased attention to negative stimuli may not inherently translate to more vivid mental imagery, particularly in non-clinical samples and when stimuli are framed in present- rather than future-tense. Interestingly, despite the lack of enhanced vividness, affective imagery in individuals with higher depressive severity was still appraised more negatively than affective perceptual stimuli,

highlighting a potential dissociation between imagery's visual vividness and its emotional impact.

This study also found depressive symptomatology to be further associated with reduced subjective perceptual clarity for positive and negative, but not neutral, pictures. This pattern of results might suggest that the integration of visual and affective processing – each of which have been observed to be hindered independently, in depression – is further disrupted, which may interfere with the clarity with which external visual material is perceived.

Another important contribution of the study lies in its comparison of dimensional and categorical approaches to modeling symptom severity. Whereas linear regression models using continuous symptom scores successfully predicted depression, anxiety, and comorbidity from a combination of internal and external appraisal variables, classification models based on categorical and multidimensional symptom groupings failed to do so. These results align with dimensional frameworks of psychopathology, suggesting that emotional and cognitive disruptions in depression and anxiety are more accurately captured along continuous spectra rather than categorical thresholds.

In sum, the current findings highlight the complexity of cognitive emotional representations in depression, underscoring the need to consider the perspective, quality, and modality (i.e., self-referential vs. non-self-referential, clear or vivid vs. vague/dim, and interoceptive vs. exteroceptive, respectively) of emotional stimuli. They also posit the value of dimensional assessment approaches in capturing the subtle interplay of affective, cognitive, and perceptual disruptions that characterize mood and anxiety symptoms. Future research using objective measures, longitudinal designs, and clinical populations will be essential for clarifying the mechanisms underpinning these processes and guiding more effective interventions.

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Appendix A

Imagery Cues

Positive ($M = 0.80$; $SD = 0.21$)

1. People are admiring you ($M = 0.77$; $SD = 0.22$).
2. You have just accomplished a long-term goal ($M = 0.86$; $SD = 0.16$).
3. You are energetic and enthusiastic ($M = 0.77$; $SD = 0.19$).
4. You are performing well under pressure ($M = 0.72$; $SD = 0.23$).
5. You have good and lasting friendships ($M = 0.85$; $SD = 0.19$).

Negative ($M = 0.18$; $SD = 0.16$)

1. You are in a serious argument with a close friend ($M = 0.20$; $SD = 0.18$).
2. You are being blamed for things going wrong ($M = 0.17$; $SD = 0.16$).
3. You are the victim of a crime ($M = 0.18$; $SD = 0.18$).
4. You are falling badly behind in your work ($M = 0.17$; $SD = 0.16$).
5. People are making fun of you behind your back ($M = 0.17$; $SD = 0.16$).

Neutral ($M = 0.63$; $SD = 0.21$)

1. You are cooking dinner ($M = 0.74$; $SD = 0.20$).
2. You are walking on the sidewalk ($M = 0.61$; $SD = 0.17$).
3. You are reading a book ($M = 0.71$; $SD = 0.21$).
4. You are waiting for the bus ($M = 0.49$; $SD = 0.19$).
5. You are browsing the internet ($M = 0.59$; $SD = 0.19$).