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The role of mental imagery in mood amplification: An investigation across subclinical features of bipolar disorders

Caitlin O'Donnell [a,b], Martina Di Simplicio [c,d], Randi Brown [a], Emily A. Holmes [e] and Stephanie Burnett Heyes [f,*]

[a] Department of Experimental Psychology, University of Oxford, Oxford, UK
[b] Graduate School of Applied and Professional Psychology, Rutgers University, USA
[c] MRC Cognition and Brain Sciences Unit, Cambridge, UK
[d] Cambridgeshire and Peterborough NHS Foundation Trust, Cambridge, UK
[e] Institute of Psychology, Department of Clinical Neuroscience, Karolinska Institutet, Sweden
[f] School of Psychology, University of Birmingham, UK

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ABSTRACT

Vivid emotional mental imagery has been identified across a range of mental disorders. In bipolar spectrum disorders – psychopathologies characterized by mood swings that alternate between depression and mania, and include irritability and mixed affect states – mental imagery has been proposed to drive instability in both 'positive' and 'negative' mood. That is, mental imagery can act as an "emotional amplifier". The current experimental study tested this hypothesis and investigated imagery characteristics associated with mood amplification using a spectrum approach to psychopathology. Young adults (N = 42) with low, medium and high scores on a measure of subclinical features of bipolar disorder (BD), i.e., hypomanic-like experiences such as overly 'positive' mood, excitement and hyperactivity, completed a mental imagery generation training task using positive picture-word cues. Results indicate that (1) mood amplification levels were dependent on self-reported hypomanic-like experiences. In particular, (2) engaging in positive mental imagery led to mood amplification of both positive and negative mood in those participants higher in hypomanic-like experiences. Further, (3) in participants scoring high for hypomanic-like experiences, greater vividness of mental imagery during the experimental task was associated with greater amplification of positive mood. Thus, for individuals with high levels of hypomanic-like experiences, the generation of emotional mental imagery may play a causal role in their mood changes. This finding has implications for understanding mechanisms driving mood amplification in bipolar spectrum disorders, such as targeting imagery vividness in therapeutic interventions.

* *Corresponding author*. School of Psychology, University of Birmingham, Edgbaston, Birmingham, B15 2TT, UK.
E-mail addresses: martina.disimplicio@mrc-cbu.cam.ac.uk (M. Di Simplicio). s.burnettheyes@bham.ac.uk (S. Burnett Heyes).
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1. Introduction

Mental imagery is the perception of an image in the 'mind's eye' when the corresponding item is not actually present (Kosslyn, Ganis, & Thompson, 2001; Pearson, Naselaris, Holmes, & Kosslyn, 2015). Mental imagery can occur in multiple sensory modalities (Kosslyn, Seger, Pani, Hillger, & Stephen, 1990). Imagery can involve both re-experiencing of the past and creating mental time travel into the future (Addis, Pan, Vu, Laiser, & Schacter, 2009; D'Argembeau, Renaud, & Van der Linden, 2011; Holmes, Mathews, Mackintosh, & Dagleish, 2008). Mental imagery can be highly emotionally-evocative compared to verbal thoughts (Holmes, Mathews et al., 2008). Emotional processing in the brain may be particularly sensitive to mental imagery (Holmes & Mathews, 2005; Pearson et al., 2015).

Studies have highlighted the importance of imagery-based symptomatology in numerous disorders (Holmes & Mathews, 2010) and recently also suggested a relationship between mental imagery and bipolar disorder (BD) (Ng, Di Simplicio, & Holmes, 2016). Investigating mental imagery in patients with mental disorders, in particular mood disorders, can reveal important aspects of the role of imagery in cognitive processes such as affect regulation, and more broadly in the maintenance of psychological wellbeing (Szpunar, Spreng, & Schacter, 2014).

BD is characterised by recurring episodes of depression and mania at various levels of duration and intensity (DSM 5 – APA, 2013). A manic episode refers to excessively elated or irritable mood and increased goal-directed activity often including disinhibition and risky behaviours, alongside other symptoms such as abnormally high energy levels, inflated self-esteem and grandiosity, distractibility, accelerated thoughts and speech, and reduced need for sleep. A depressive episode instead presents with depressed (low) mood, lack of motivation and anhedonia, together with other symptoms such as low energy levels, disturbed sleep and appetite, indecisiveness, concentration and memory difficulties, psychomotor retardation or agitation, and feelings of guilt, hopelessness and helplessness. Individuals with BD also often experience so called 'mixed features' (the presence of subclinical symptoms of mania during depressive episodes or vice versa, APA, 2013), which predict greater symptom severity and less time spent in stable mood (Goldberg et al., 2009; Miller et al., 2016; Young & Eberhard, 2015). Finally, mood instability defined as 'rapid oscillations of intense affect' (Marwaha et al., 2014; Broome, Saunders, Harrison, & Marwaha, 2015) is also very frequent in BD (Bopp et al., 2010; M'bailara et al., 2009; Strejilevich et al., 2013) and is perhaps associated with mixed features (Miller et al., 2016).

Following a dimensional approach to psychopathology, a bipolar *spectrum* has also been identified in various ways (Akiskal & Pinto, 1999; Angst, 2007), and refers to conditions that include not only BD as categorized by the DSM (see above), but also temperamental and subclinical features of manic and depressive mood amplification. At the subclinical end of the bipolar spectrum, 'hypomanic-like' experiences are characterised by excessively high positive mood together with some of the other features of mania described above. Hypomanic experiences are considered a risk factor for the development of full blown BD (Axelson et al., 2015; Hirschfeld et al., 2000; Lewinsohn, Seeley, & Klein, 2003).

Several studies have indicated a correlation between bipolar spectrum features and self-report measures of mental imagery.

Hypomanic-traits. Individuals with high levels of hypomanic-like experiences have been found to present increased trait-like tendency to spontaneously experience emotionally-neutral imagery and a greater emotional impact of imagery for the future (Deeprose & Holmes, 2010; Malik, Goodwin, Hoppitt, & Holmes, 2014; McGill & Moulds, 2014) measured by self-report scales (the Spontaneous Use of Imagery Scale – SUIS, Nelis, Holmes, Griffith, & Raes, 2014; and the Impact of Future Events Scale, IFES, Deeprose & Holmes, 2010). Levels of intrusive visual imagery measured via a bespoke questionnaire (not limited to imagery of the future) predicted levels of hypomania in another large sample study (McCarthy-Jones, Knowles, & Rowse, 2012). Finally, high hypomanic-traits have also been associated with greater susceptibility to experience more intrusive imagery following exposure to an experimental trauma film paradigm (Malik et al., 2014).

Bipolar disorder. Increased trait-like tendency to spontaneously experience emotionally-neutral imagery and a greater emotional impact of imagery for the future have been reported also in individuals with BD (Hales, Deeprose, Goodwin, & Holmes, 2011; Holmes et al., 2011; Ng, Burnett Heyes, McManus, Kennerley, & Holmes, 2016), as well as a higher reported frequency of imagery use over verbal thought over the previous week measured on a visual analogue scale (Holmes et al., 2011). The relationship between higher reported frequency of imagery use over verbal thought and BD was also found using semi-structured interviews that asked individuals to describe the experience of imagery and verbal cognitions at times of positive mood, for example how exciting or compelling were mental images and verbal thoughts (Ivins, Di Simplicio, Close, Goodwin, & Holmes, 2014). More vivid and 'real' negative imagery was found in a BD sample compared to healthy controls during an experimental task where participants had to generate images from a list of positive and negative future scenarios (Di Simplicio et al., 2016; Holmes et al., 2011). Compared to healthy controls, individuals with BD also reported higher self-involvement in negative imagery in a picture-word task (similar to the one described in this paper, see Methods) where participants had to generate imagery from negative picture-word combinations (Di Simplicio et al., 2016). In summary, consistent evidence from studies on subclinical populations and on patients with BD supports the dimensional approach to psychopathology where similar biases in cognitive processing, e.g., mental imagery, are present across the bipolar spectrum.

This evidence suggests that investigating imagery characteristics in individuals across the bipolar spectrum can expand our knowledge of the special association between imagery and emotional processing (Holmes & Mathews, 2005), and its impact on mood. Holmes, Geddes, Colom, Goodwin (2008) and Holmes and Mathews (2010) proposed a cognitive model – modified from Clark's cyclical panic model of anxiety

(1986) – whereby mental imagery may act as an 'emotional amplifier' for mood in psychopathology, exacerbating both manic and depressed states as well as anxiety in BD (Holmes, Geddes et al., 2008). In this model, emotional mental imagery amplifies both anxious and hypomanic/manic states, moderating feedback loops for negative and positive mood in BD. Therefore, greater susceptibility to mental imagery across the bipolar spectrum could lead to greater mood amplification.

Evidence that emotionally-valenced mental imagery amplifies mood has been shown using experimental paradigms in non-clinical participants not characterised for the presence of hypomanic traits (Holmes, Coughtrey, & Connor, 2008; Holmes, Geddes et al., 2008; Holmes, Lang, & Shah, 2009). Evidence for the emotional amplification hypothesis in BD exists, but it is limited. For example, in a correlational study using semi-structured interviews, imagery of suicide in BD was linked to higher self-reported desire to carry out suicide attempts (Hales et al., 2011; McGill & Moulds, 2014). Additionally, higher self-reported intrusive prospective imagery in individuals with BD showed a correlative relationship with greater mood instability (Di Simplicio et al., 2016; Holmes et al., 2011), and targeting intrusive imagery in BD has been shown to reduce mood instability (Holmes, Bonsall et al., 2016). However, whether mood amplification is more pronounced in non-clinical individuals within the bipolar spectrum *as a result of* imagery generation remains untested. Furthermore, it is important to use a standardized task (here an imagery generation task using picture-word stimuli) rather than exclusive reliance on self-report questionnaires or clinical interviews pertaining to mental imagery. This study adds new evidence to the mood amplification hypothesis by testing for the first time the effects of a standardised experimental paradigm of imagery generation on mood amplification in non-clinical volunteers characterised for the presence of hypomanic traits.

This paper will focus on a subclinical group of young adults reporting a range of hypomanic-like experiences. Studying young adults high in hypomanic-like experiences could be particularly advantageous as these individuals are at high-risk for developing BD, but are un-medicated and their cognitive processes are not confounded by acute illness state (Rock, Chandler, Harmer, Rogers, & Goodwin, 2013). Therefore, this approach could shed light on how cognitive models contribute to etiological (i.e., risk) mechanisms (Waugh, Meyer, Youngstrom, & Scott, 2014). To measure hypomanic-like experiences on a continuum across participants, this study used the Mood Disorder Questionnaire (MDQ; Hirschfeld et al., 2000) a self-report questionnaire assessing trait levels of hypomanic-like experiences.

This study will address questions pertaining to the emotional amplification hypothesis (Holmes, Geddes et al., 2008), focussing on its manic/hypomanic mood escalation aspect. To begin with, does emotional mental imagery generation on a standardized task in the laboratory alter mood, and is this effect different dependent on the presence of hypomanic-like experiences in a sub-clinical population? Additionally, since BD is characterized by amplification of both positive and negative mood and by mixed features (Goldberg et al., 2009; Miller et al., 2016; Young & Eberhard, 2015), does positive imagery generation lead to greater mood amplification, i.e., greater magnitude of change, in either or both positive and negative mood, in individuals reporting more hypomanic-like experiences? Last, does imagery vividness moderate the relationship between hypomanic-like experiences and mood amplification (Di Simplicio et al., 2016; Holmes, Blackwell, Burnett Heyes, Renner, & Raes, 2016; Holmes, Bonsall et al., 2016; Ji, Burnett Heyes, MacLeod, & Holmes, 2016)? This study hypothesized that experimental positive mental imagery generation would lead to greater positive mood amplification and/or mood amplification of both positive and negative mood in individuals higher in hypomanic-like experiences, and evaluated whether this relationship was more pronounced when mental images during the task were rated as more vivid. See Fig. 1 illustrating the model of relationships between hypomanic-like experiences (trait) and mood amplification (change in state affect) induced by imagery.

2. Methods

2.1. Participants

Forty-two participants (17 men, 25 women) aged 18–25 ($M = 22.36$, $SD = 1.71$) completed the experimental study and were paid for their participation. Participants were recruited through posters and online advertisements at the University of Oxford and in the local community. The study was approved by the University of Oxford Central University Research Ethics Committee (MS-IDREC-C1-2015-027) and written informed consent was obtained from all participants. See Table 1 for participant characteristics.

2.1.1. Participant pre-screening

To recruit individuals across a range of hypomanic-like experiences, potential participants were first prescreened by completion of the MDQ (Hirschfeld et al., 2000). One hundred twenty-two participants completed the pre-screening and were categorized according to the number of hypomanic-like experiences reported in section A of the MDQ (0–13): high MDQ ($n = 35$; scoring ≥ 7; range = 7–13), medium MDQ ($n = 28$; $3 <$ scoring < 7; range = 4–6), and low MDQ ($n = 59$; scoring ≤ 3; range = 0–3). From this sample, high ($n = 28$), medium ($n = 25$) and low ($n = 20$) MDQ scoring participants were contacted for participation in the experimental session to recruit even numbers across the three groups. Not all participants re-enrolled post-screening. Forty-five participants recruited through pre-screening attended the experimental session with high ($n = 15$), medium ($n = 15$), and low ($n = 15$) MDQ scores. Of these, a final sample of 42 completed the experimental study with high ($n = 12$), medium ($n = 15$), and low ($n = 15$) MDQ scores (Fig. 2).

2.2. Procedure

The experimental session began with psychiatric screening using the Mini International Neuro-psychiatric

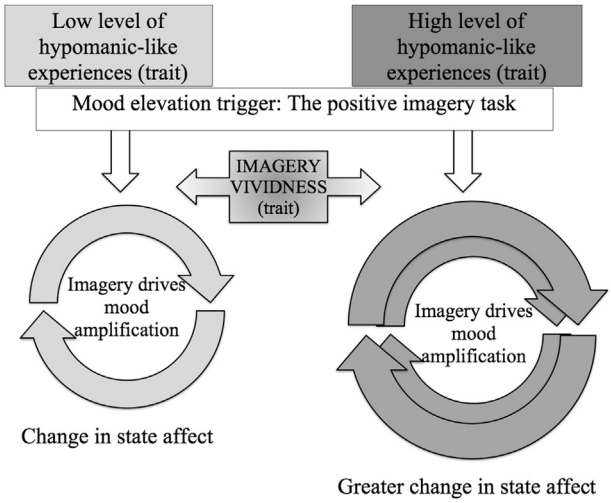

Fig. 1 – Imagery-based mood amplification and hypomanic-like experiences.

1) Based on previous literature on the relationship between emotion and imagery, we hypothesise that the positive imagery generation task produces a change in state affect. See circular arrows = mood amplification.
2) Based on previous data showing that individuals with higher hypomanic-like experiences present greater imagery tendency and ability traits, we hypothesise that mood amplification (change in state affect) following the positive imagery generation task is greater in individuals with higher hypomanic-like experiences (trait). See darker, thicker circular arrows = larger mood amplification.
3) We explore if ability traits to generate vivid imagery influence mood amplification (change in state affect) depending on the level of hypomanic traits. See central shaded arrows = impact of imagery vividness on mood amplification.

Interview–Plus (MINI-Plus; Sheehan et al., 1998). A history of clinical BD was an exclusion criterion and three participants were excluded based on this criterion. After a 15-min break participants completed self-report emotional and imagery measures and a self-report measure of current mood, followed by valence ratings of picture pleasantness and a short behavioural task (not reported). Participants then completed a standardized imagery generation training procedure followed by a positive picture-word cue imagery generation task including trial-by-trial vividness ratings. Following the imagery generation task, participants again completed the self-report measure of current mood preceded by valence ratings of picture pleasantness. They also completed a short behavioural task (data not reported) comprising a toy game in which 32 plastic fish move in a circular base, opening and closing their mouths to expose a magnet. As in Pictet et al. (2011), participants were instructed to catch as many fish as they could in 2.5 min using a plastic fishing rod with a magnetic lure. Participants ended by completing measures of subjective experience of creating mental images during the imagery generation task, demand characteristics and demographic information. Participants were debriefed, thanked, and compensated for their time (see Fig. 2).

2.3. Measures

An overview of measures used is summarised in Table 1.

2.3.1. Demographic information, psychiatric screening and self-report affect measures

Participants reported their gender identity, age, marital status, current education status (student or non-student) and ethnicity. The MINI-Plus (Sheehan et al., 1998) is a brief structured interview to assess current and lifetime major Axis I disorders in the *Diagnostic and Statistical Manual of Mental Disorders, 4th ed., Text Revision* (American Psychiatric Association, 2000). Hypomanic-like experiences, current depressive symptoms, trait anxiety and current mood were measured via self-report:

The MDQ (Hirschfeld et al., 2000) is a self-report questionnaire assessing trait levels of hypomanic-like experiences and was used in this study in two separate ways: 1) as a pre-screening measure (see *Participant Pre-screening)* and 2) to quantify hypomanic-like experiences on a continuum across participants. The MDQ is the most widely used and best validated screening tool for hypomania (Waugh et al., 2014). The questionnaire asks participants about a period of time in which they were 'not their usual self' and felt more elated or irritable than usual. The measure is comprised of three sections. Only section A was used as the validity of MDQ in young adult populations in its entirety has been put into question (Waugh et al., 2014), and furthermore because this section gives a relatively continuous measure of hypomanic-like experiences. Section A contains 13 yes/no items describing manic/hypomanic symptoms (e.g., 'you had much more energy than usual'). Hypomanic-like experiences, reflecting a spectrum of bipolarity, not just diagnostic cut-offs, were evaluated (Judd & Akiskal, 2003). Thus, the scale was used to establish cut-off scores to recruit participants across a range of low, medium, and high hypomanic-like experiences (see *Participant Pre-screening)*, but was otherwise used on a continuous scale to measure a spectrum of hypomanic-like experiences. Possible scores ranged from 0 to 13. Higher scores reflect greater hypomanic-like experiences (sub-clinical bipolar spectrum).

The Beck Depression Inventory–Second Edition (BDI-II; Beck, Steer, & Brown, 1996) was used to assess current depressive symptomatology over the preceding 2 weeks to further characterise the mood profile of participants. Participants answered 21 self-report items describing current depressive symptoms. This scale has robust reliability and validity (clinical outpatients: $\alpha = .92$; student samples: $\alpha = .93$; Beck, Steer, Ball, & Ranieri, 1996; Beck, Steer, & Brown, 1996).

The State Trait Anxiety Index-Trait (STAI-T; Spielberger & Gorsuch, 1983) was used to measure trait anxiety across a continuum. Participants answered 20 anxiety related items rating 'how [they] generally feel'. This measure is reported to

Table 1 – Overview of measures used in the study.

Clinical measures validated in large samples and widely used		Mini International Neuro-psychiatric Interview–Plus (MINI-Plus)	Sheehan et al., 1998
		Beck Depression Inventory–Second Edition (BDI-II)	Beck, Steer, & Brown, 1996
		State Trait Anxiety Index-Trait (STAI-T)	Spielberger & Gorsuch, 1983
Clinical measures validated in large samples and widely used in bipolar disorder research		Mood Disorder Questionnaire (MDQ)	Hirschfeld et al., 2000
Non-clinical measures validated in large samples and widely used*	*note that new scoring method and outcome measure was added to this scale for this study*	Positive and Negative Affect Schedule (PANAS) State+	Watson et al., 1988
Mental imagery measures/tasks validated and used in numerous previous studies	Developed by Holmes et al.	Positive Picture-word Imagery Generation Task, with Vividness Ratings and Valence Ratings of Picture Pleasantness	Blackwell et al., 2015; Burnett Heyes et al., 2017; Holmes, Geddes et al., 2008; Pictet et al., 2011
	Developed by others	Spontaneous Use of Imagery Scale (SUIS)	Reisberg et al., 2003
Mental imagery measures used in previous studies	Developed by Holmes et al.	Predominance of Verbal and Imagery-based Thoughts Visual Analogue Scale (VAS)	Holmes et al., 2011; Holmes, Geddes et al., 2008

have satisfactory reliability and validity (Spielberger & Gorsuch, 1983).

2.3.2. *Mental imagery and verbal thought scales*

The SUIS (Reisberg, Pearson, & Kosslyn, 2003) is a self–report instrument that provides a trait measure of spontaneous use of imagery in everyday life. The SUIS has good internal consistency ($\alpha = .72$ to .76; Nelis et al., 2014) and contains 12 items, including 'When I first hear a friend's voice, a visual image of him or her almost always comes to mind' (Reisberg et al., 2003).

The Predominance of Verbal and Imagery-based Thoughts Visual Analogue Scale (VAS; Holmes et al., 2011; Holmes, Geddes et al., 2008) was used to measure use of mental imagery and verbal thought. Participants were asked to mark 'How much of the time has your thinking taken the form of *verbal thoughts* over the past 7 days?', and 'How much of the time has your thinking taken the form of *mental imagery* over the past 7 days?', along two analogue scales from 'none of the time' to 'all of the time'.

2.3.3. *Mental imagery task*

2.3.3.1. Standardised imagery generation training procedure. Imagery generation training followed a similar protocol to Holmes, Geddes et al. (2008). Mental imagery was defined and participants practiced creating mental images from a field (first person) perspective. The experimenter guided participants through a standardized imagery generation task of imagining cutting a lemon (Burnett Heyes et al., 2017; Holmes, Geddes et al., 2008). Participants were then introduced to generating mental images using picture-word cues and instructed to form images from their own perspective, by combining the picture and the phrase to create a mental image. Participants completed three practice trials on paper and four on the computer. Throughout the lemon exercise and after each picture-word cue, participants were instructed to close their eyes to form a mental image. When cued, participants then opened their eyes to report the vividness and descriptions of their mental images to the experimenter.

2.3.3.2. Positive picture-word imagery generation task and vividness ratings. After completing the standardised imagery generation training procedure, participants took part in a computerized positive picture-word imagery generation task. Participants generated mental images in response to picture-word cues presented on a laptop computer and reported mental imagery vividness after each (Burnett Heyes et al., 2017; Holmes, Geddes et al., 2008; Pictet et al., 2011). Stimuli, 90 picture-word cues, were presented on a Dell PC E6320 using E-Prime software in 6 randomized blocks of 15. Each picture-word cue was presented for 4500 msec followed by a 1000 msec beep. The beep indicated participants could open their eyes and rate vividness on a five-point scale (1, 'not at all vivid'; 5, 'extremely vivid'). Vividness ratings were used first, to encourage compliance with the instructions and attention to the task (Burnett Heyes et al., 2017; Holmes, Geddes et al., 2008; Pictet et al., 2011), and second to measure imagery ability during the task (Blackwell et al., 2015). At the end of each block, participants were prompted to speak to the experimenter. Participants described their most recent image and experimenters provided verbal feedback and reminders of task instructions.

Picture-word cues were presented centred on the 13″ VDU against a black background. Pictures varied slightly in size: width ranged from 360 to 640, and height ranged from 338 to 453 pixels. Images were selected from previous studies (Burnett Heyes et al., 2017; Pictet et al., 2011), photographed by the authors, or downloaded from the Internet. Pictures were emotionally ambiguous, uncluttered scenes without visible faces or text in the foreground. Words were displayed in white in Arial size 30 font and centred beneath the image. Words encouraged a positive evaluation of the stimuli (e.g., a picture of a skating rink and the word 'exhilarating'; a picture of the country side and the words 'fun walk', a picture of cream and a scone and the words 'yummy treat') and were short phrases used in previous studies (Burnett Heyes et al., 2017; Pictet et al., 2011) or created by the authors for the current study.

As a manipulation check for task compliance participants were asked about their subjective experience of the

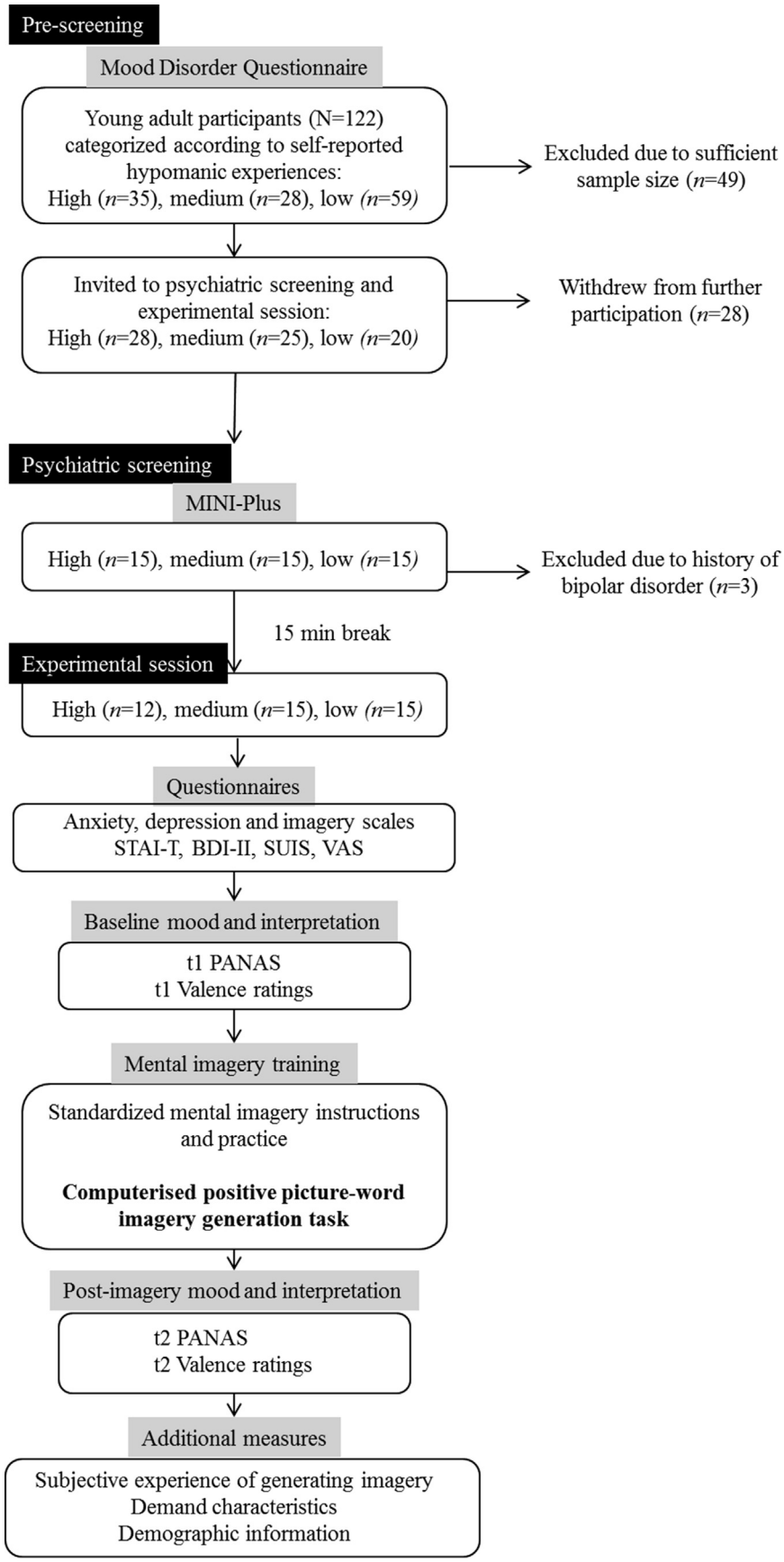

Fig. 2 – Experimental procedure.

picture–word imagery generation task at the end of the experiment (Pictet et al., 2011). Participants reported how difficult they found the task, how much they were able to combine pictures and words to generate a mental image, how much they were verbally analysing the picture–word combinations, and how much they were using field perspective. Ratings were made on a 9-point scale (1, 'very easy/none of the time '; 9 'very difficult/all of the time').

To check for demand characteristics, participants indicated whether they thought mental imagery during the task affected their emotions on a 9-point scale (1, 'much more negative'; 9 'much more positive'; Holmes, Geddes et al., 2008).

2.3.3.3. Valence ratings of picture pleasantness. Fifty pictures were drawn randomly from the set of 90 used in the picture-word imagery generation task. Participants rated each picture on pleasantness using a 9-point scale (1, 'extremely unpleasant'; 9 'extremely pleasant') (Holmes, Geddes et al., 2008; Pictet et al., 2011) before and after the Positive Picture-word Imagery Generation Task.

2.3.4. *Current mood and mood change*

The Positive and Negative Affect Schedule (PANAS) State+ (Watson & Clark, 1999; Watson, Clark, & Tellegen, 1988) was used to current measure positive and negative state affect (current mood). The PANAS (State+) contains 33 words describing emotions and feelings. A positive 21-item subscale includes the basic positive emotion scales (joviality, eight items; self-assurance, six items; attentiveness, four items) and the serenity subscale (three items). The negative 10-item subscale includes items such as distressed, upset, guilty, and scared. Participants are instructed to "indicate to what extent you feel this way right now" using a 5-point scale (1, not at all; 5, extremely) to rate each item presented. The standard approach to measuring mood using the PANAS is to sum positive and negative subscales separately (e.g., Holmes et al., 2006). However, as we were interested in capturing changes in mood relevant to the bipolar spectrum where positive and negative mood can co-exist (Miller et al., 2016) and vary together (Bopp et al., 2010), we adopted a novel way of scoring data from the PANAS State+ by considering the positive and negative sub scales together instead of separately. Data from both PANAS State+ subscales together was used to derive the following new variables: Mood positivity, change in mood positivity (i.e., positive mood amplification), mood magnitude, change in mood magnitude (i.e., mood amplification).

Mood positivity was calculated by subtracting the sum of the 10-item negative affect scale from the sum of the positive 21-item subscale, so to derive a metric that captures mood positivity including the lack of negative mood. Change in mood positivity from pre-to post-experimental imagery generation was calculated as an increase in the positive 21-item subscale and decrease in the 10-item negative affect scale. In other words, this was the increase in positive PANAS items plus the decrease in negative PANAS items. A negative change score indicates reporting more negative affect and/or less positive affect after the task and a positive change score indicates feeling more positive affect and/or less negative affect after the task (i.e., positive mood amplification).

Mood magnitude was calculated as the sum across all PANAS items (positive and negative). Change in mood magnitude from pre-to post-task was calculated from the change in the 21-item positive PANAS subscale plus the change in the 10-item negative PANAS subscale. Thus, a low change score indicates little change in combined negative and positive affect, and a large change score indicates large change in combined negative and positive affect (i.e., mood amplification). This variable was derived as an omnibus measure of mood change irrespective of its valence, given the relevance of mixed mood and mood instability with respect to bipolar spectrum disorders (Bonsall, Geddes, Goodwin, & Holmes, 2015; Bonsall, Wallace-Hadrill, Geddes, Goodwin, & Holmes, 2012; Holmes, Blackwell et al., 2016; Holmes, Bonsall et al., 2016; Holmes et al., 2011; Strejilevich et al., 2013; Swann et al., 2013).

2.4. *Data analysis plan*

Skewness and kurtosis z-scores were calculated for each variable to check the assumption of normality. A z-scores less than 2.58 and greater than −2.58 was used to represent a normal distribution ($p < .01$) as recommended in small sample sizes (Field, 2009). Accordingly, parametric or non-parametric equivalents of standard parametric tests were used where appropriate to test hypotheses.

Differences in baseline characteristics across the three recruitment groups (low, medium and high MDQ) were investigated using one-way ANOVA or, where normality assumptions were not met, Kruskal–Wallis H test, for continuous variables (BDI-II and STAI-T scores; baseline PANAS mood positivity; baseline valence) and Chi-square tests for categorical variables (demographic characteristics; MINI-Plus mental disorders: lifetime prevalence of mental disorders, current or lifetime major depressive episode, current anxiety disorder, lifetime or current substance dependency, substance abuse). Potentially confounding effects of MDQ score on subjective experiences of generating imagery during the experiment were investigated using correlations. Potentially confounding MDQ group differences on demand characteristics were investigated using one-way ANOVA.

To investigate our a priori hypotheses on the impact of the imagery generation task, Wilcoxon Signed Ranks tests compared PANAS mood magnitude, PANAS mood positivity and valence ratings of picture pleasantness pre-to post-imagery generation across the sample. Correlations were used to assess hypothesised relationships between MDQ scores and mood change measures (change in mood positivity, change in mood magnitude). Post hoc, hierarchical regression and a moderation analysis (Hayes, 2013) tested whether vividness during the imagery generation task moderated the predicted relationships between hypomanic-like experiences and change in mood positivity/change in mood magnitude.

Correlations were used to assess a priori relationships between MDQ scores and mental imagery and verbal thought scales based on previous literature findings (SUIS; VAS predominance of verbal and imagery-based thoughts over the past seven days) (Di Simplicio et al., 2016; Hales et al., 2011; Holmes et al., 2011; Ng, Burnett Heyes, et al., 2016; Ng, Di

Simplicio, et al., 2016). Additionally post-hoc analysis explored relationships between MDQ scores and mental imagery measures collected during the task (subjective experience of creating mental imagery during imagery generation task; vividness during task).

All analyses were conducted with alpha set at .05 and using SPSS Version 22.0. The moderation analysis also used PROCESS, installed in SPSS (Hayes, 2013).

3. Results

3.1. Demographic information, psychiatric screening and self-report affect measures

The three groups (high *vs* medium *vs* low scores on the MDQ) did not differ in terms of gender, age, marital status, current education status, or ethnicity. See Table 2.

Prevalence of lifetime and current mental disorders, assessed using the MINI-Plus, indicated differences across MDQ groups in lifetime prevalence of mental disorders, current anxiety disorder and lifetime or current substance dependency and close to significant group difference in substance abuse. There was no MDQ group difference in frequency of current or lifetime major depressive episode. Groups did not differ on current depression score, baseline PANAS mood magnitude or baseline PANAS mood positivity. Trait anxiety differed across MDQ groups. See Table 2.

3.2. Mental imagery and verbal thought scales

MDQ score showed a significant relationship with imagery measures. Higher MDQ scores were related to higher mental imagery use over the past 7 days [VAS; $r(40) = .39$, $p < .01$] and higher SUIS scores [$r(40) = .31$, $p < .05$]. Higher MDQ scores were not related to higher verbal thought use over the past 7 days [VAS; $r(40) = .14$, $p = .37$]. See Table 3.

3.3. Mental imagery generation task

There was no significant relationship between hypomanic-like experiences assessed on a continuous scale (MDQ score) and subjective experiences of generating imagery during the experimental task: how easy participants found the task [$r(40) = .18$, $p = .25$]; how able participants were to combine pictures and words to generate a mental image [$r_s(40) = .22$, $p = .15$]; use of verbal processing during the imagery task [$r(40) = -.03$, $p = .84$]; use of field perspective [r_s $(40) = .23$, $p = .138$]. On average participants judged that the mental imagery task resulted in them feeling more positive ($M = 6.98$, $SD = 1.26$), but this did not differ significantly between MDQ groups [$F(2,41) = 1.57$, $p = .22$].

Kruskal–Wallis H test showed a statistically significant difference across MDQ groups in baseline valence ratings of picture pleasantness ($p = .03$). Wilcoxon signed-ranks test showed that from pre- ($M = 6.1$, $SD = .54$) to post- ($M = 6.70$, $SD = .77$) imagery generation task there was a significant increase in valence ratings of picture pleasantness across participants ($Z = -4.80$, $p < .001$; mean increase $= .59$, $SD = .63$). Finally, higher MDQ scores were related to higher vividness ratings of images during the imagery generation task [$r(40) = .40$, $p = .01$].

3.4. Change in current mood after imagery generation task

All following results are reported in Table 2. Wilcoxon signed-ranks tests did not show a significant change in mood positivity (PANAS mood positivity: $Z = -.83$, $p = .41$), but a significant change in mood magnitude (PANAS mood magnitude score: $Z = -5.65$, $p < .001$), from pre-to post-imagery generation task across the sample.

Contrary to prediction, MDQ scores did not show a significant relationship with change in mood positivity [$r(40) = .11$, $p = .50$] from pre to post imagery generation task (positive mood amplification). However, as predicted, MDQ scores correlated with change in mood magnitude [$r_s(40) = .42$, $p = .005$] pre to post imagery (mood amplification).

Vividness and change in mood positivity (positive mood amplification). Given we predicted a relationship between hypomanic-like experiences and change in mood positivity following imagery generation, we conducted the following *post hoc* analysis. Imagery vividness during the imagery generation task was examined as a moderator driving the hypothesised relationship between MDQ scores and change in mood positivity. We hypothesised that, since MDQ scores did not predict a simple change in mood positivity, individual variation in vividness could potentially be masking an underlying relationship. A hierarchical multiple regression analysis was conducted. In Step one, two predictor variables were included: vividness and MDQ scores. This model did not predict positive mood amplification [$F(2,39) = 1.07$, $p = .354$, $R^2 = .052$]. In Step two, variables were centred to avoid multicollinearity and an interaction term between MDQ scores and vividness was included (Aiken & West, 1991). When the interaction term was added, the regression model predicted change in mood positivity [$F(3,38) = 2.85$, $p = .05$, $R^2 = .184$], with individually significant effects of MDQ score ($b = -7.42$, $t = -2.31$ $p = .027$) and interaction between MDQ score and vividness ($b = 2.10$, $t = 2.48$, $p = .018$), and a marginal effect of vividness ($b = -6.75$, $t = -1.70$, $p = .098$). This model was a significant improvement from the previous model [$\Delta R^2 = .13$, $\Delta F(1,38) = 6.14$, $p < .05$, $b = 2.1$, $t(3,38) = 2.48$, $p < .05$]. Analysis of conditional effects of dependent on independent variables across values of the moderator showed that change in mood positivity following imagery generation differed significantly across levels of hypomanic-like experiences when vividness was high ($t = 2.56$, $p = .015$), but not when it was medium ($p = .736$) or low ($p = .139$). Thus, at high vividness (>3.5 on 1 to 5 likert scale, see Fig. 3), change in mood positivity (positive mood amplification) did vary across MDQ scores.

Vividness and change in mood magnitude (mood amplification). In a further *post hoc* analysis, vividness of images during the imagery generation task was examined as a moderator driving the observed relationship between MDQ scores and change in mood magnitude. That is, this analysis tested whether mood change – both positive and negative –varied as a function of mental imagery vividness and hypomanic experiences. A hierarchical multiple regression analysis was conducted. In Step one, two predictor variables were included: vividness and

Table 2 – Demographic characteristics, emotional measures, mood and valence ratings at baseline for high MDQ, medium MDQ and low MDQ groups.

Scale	Low MDQ ($n = 15$)		Medium MDQ ($n = 15$)		High MDQ ($n = 12$)		Type of test	Sig (p)
	M	SD	M	SD	M	SD		
BDI-II	4.07	3.73	5.73	7.04	7.8	6.12	$F = 1.56$	.22
STAI-T	32.4	9.61	37.93	11.55	42.5	10.65	$F = 3.29$	.01*
PANAS (Positivity)	50.87	8.66	57	14.26	50.23	14.64	H	.71
PANAS (Magnitude)	74.2	10.6	81.7	14.2	77.6	13.5	$F = 1.27$	.29
Age (years)	22.93	1.62	21.8	1.78	22.33	1.63	$F = 1.71$	.20
Gender (%)								
Female	60%		53.33%		66%		$\chi^2 = .56$	.76
Male	40%		46.66%		33%			
Marital status (%)								
Single	100%		80%		86.6%		$\chi^2 = 4.32$	.36
Married	0%		6.66%		0%			
Other	0%		13.33%		13.33%			
Occupation (%)								
Student	80%		60%		66%		$\chi^2 = 1.45$	.48
Not-student	20%		40%		33%			
Ethnicity (%)								
White	73.33%		53.33%		53.33%		$\chi^2 = 1.67$	.44
Other	26.66%		46.66%		46.66%			
Lifetime prevalence of mental disorders (%)	13.33%		46%		73%		$\chi^2 = 10.98$	.004**
Current anxiety disorder (%)	6.66%		33.33%		46.66%		$\chi^2 = 6.06$	.048*
Current or lifetime substance dependency (%)	0%		0%		40%		$\chi^2 = 13.85$	.001***
Current or lifetime substance abuse (%)	6.66%		13.33%		40%		$\chi^2 = 5.83$	.054
Current or lifetime major depressive episode (%)	6.66%		20%		33.33%		$\chi^2 = 3.33$	.189

Note. BDI-II = Beck Depression Inventory-II, STAI-T = Spielberger State-Trait Anxiety Inventory, PANAS (Positivity) = baseline total positive affect 21 score from the PANAS, PANAS (Magnitude) = baseline total sum of positive 21 and negative affect from the PANAS, Valence Ratings = baseline ratings of picture pleasantness. *$p < .05$ **$p < .01$. ***$p < .001$.

MDQ scores. This model predicted change in mood magnitude [$F(2,39) = 5.68$, $p = .007$, $R^2 = .226$], with an individually significant effect of MDQ score ($\beta = .438$, $t = 2.86$, $p = .007$) but not vividness ($p = .610$). In Step two, variables were centred to avoid multicollinearity and an interaction term between MDQ scores and vividness was included (Aiken & West, 1991). When the interaction term was added, the model as a whole remained a predictor of change in mood magnitude [$F(3,38) = 3.754$, $p = .019$, $R^2 = .229$], although the predictor variables were not individually significant (MDQ score: $p = .996$; vividness: $p = .988$; MDQ*vividness: $p = .709$) and the model did not significantly improve [$F(1,38) = .141$, $p = .710$, $\Delta R^2 = .003$]. Thus, variations in vividness levels of imagery do not accounts for change in mood magnitude (mood amplification) across MDQ scores.

4. Discussion

This study is the first to experimentally investigate the role of mental imagery in mood amplification, and in particular for *positive* mood, following a positive mental imagery generation

Table 3 – Correlations of MDQ levels with measures of mental imagery, verbal thought, and mood change.

Scale	Low MDQ ($n = 15$)		Medium MDQ ($n = 15$)		High MDQ ($n = 12$)		Correlation
	M	SD	M	SD	M	SD	
SUIS	38.6	7.14	39.4	7.26	39.4	7.25	.31*
VAS (Verbal thought)	5.09	2.61	6.01	2.24	5.86	2.57	.14
VAS (Mental imagery)	5.56	2.67	6.42	1.9	7.47	2.03	.39**
Average vividness rating	3.26	.68	3.62	.75	4.00	.33	.4**
Change in mood magnitude (mood amplification)	6.8	3.4	8.06	4.28	12.72	7.08	.47**
Change in mood positivity (positive mood amplification)	−.93	7.04	1.40	8.46	5.05	13.55	.21

Note. SUIS = Spontaneous Use of Imagery Scale, VAS (Verbal Thought) = Predominance of Verbal-based Thoughts Visual Analogue Scale, VAS (Mental Imagery) = Predominance of Imagery-based Thoughts Visual Analogue Scale, Change in mood positivity = change from baseline to after the imagery generation task in total positive affect 21 score from the PANAS, Change in mood magnitude = change from baseline to after the imagery generation task in total sum of positive 21 and negative affect from the PANAS. *$p < .05$ **$p < .01$. ***$p < .001$.

task in participants with low, medium and high levels of hypomanic-like experiences. Results indicate that mood amplification following positive mental imagery generation was dependent on the level of hypomanic-like experiences: greater self-reported levels of hypomanic-like experiences were associated with greater mood amplification (greater increase in mood magnitude – both positive and negative), providing partial support for the emotional amplifier hypothesis (Holmes, Geddes et al., 2008; Holmes and Mathews, 2010). While there was no simple relationship between hypomanic-like experiences and change in positivity of mood following positive imagery generation, *post hoc* moderation analysis showed evidence that, for participants high in hypomanic-like experiences (but not those with low or medium MDQ scores), vividness of mental imagery during the task was associated with the most marked *positive* mood amplification. We suggest that these results provide the first direct experimental evidence that emotional mental imagery may play a role in mood amplification related to the bipolar spectrum.

Hypomanic-like experiences and mental imagery. The current study found an association between hypomanic-like experiences measured on a continuous scale (MDQ) and several measures of mental imagery ability/use, replicating and extending previous findings (Deeprose & Holmes, 2010; Malik et al., 2014; McCarthy-Jones, et al., 2012; McGill & Moulds, 2014). Higher levels of vividness during the experimental task, higher self-reported tendency to use mental imagery in daily life (VAS), and higher self-reported spontaneous use of imagery (SUIS), were all associated with more hypomanic-like experiences. There was no relationship between hypomanic experiences and self-reported tendency to engage in verbal thought on the single item measure (VAS).

Hypomanic-like experiences and mental imagery–mood amplification hypothesis. Most previous research looking at the link between mental imagery and the bipolar spectrum was cross-sectional, e.g., comparing a clinical versus a non-clinical group, and thus could not inform whether there was a causal link between mental imagery and mood amplification. Using a positive picture-word imagery generation task, the current study found tentative supporting evidence for the emotional amplification hypothesis, which proposes that mental imagery moderates feedback loops for mood escalation in BD (Holmes, Geddes et al., 2008; Holmes et al., 2010). In the current study, a greater number of hypomanic-like experiences was associated with greater mood amplification following the positive imagery generation task. In other words, the role of mental imagery in mood amplification may be secondary to individual traits such as the presence of bipolar spectrum features. The positive imagery generation procedure resulted in greater total mood change in individuals reporting more hypomanic-like experiences.

Contrary to our predictions, we did not find a simple relationship between hypomanic-like experiences and *positive* mood amplification following the positive imagery generation task. Instead, the relationship existed only for mood amplification, intended as the combined magnitude of change across positive and negative mood subscales. This could be partly explained by the observation that mania is not simply 'happy mood', but also includes irritability (American Psychiatric Association, 2013) and is often accompanied by depressive features and anxiety (so called mixed states, Young & Ebelhardt, 2015). Further, the onset of a manic-like state entails both positive and negative mood change (Gonzalez-Pinto et al., 2003; Swann et al., 2013). This is consistent with our finding of increased mood amplification regardless of valence in the current study – that is, the positive imagery generation task induced changes across combined positive *and* negative affect in individuals high in hypomanic-like experiences, potentially resembling aspects of hypomania which includes negative affect features. Clinical and experimental evidence (Holmes, Bonsall et al., 2016; Kelly, Mansell, Sadhnani, & Wood, 2012, Kelly, Smith, Leigh, & Mansell, 2016) suggests that individuals on a bipolar spectrum can attribute negative meanings to positive emotions and arousal (e.g., "I am losing control of my emotions"), and this can drive irritability and negative emotions (Kelly et al., 2016). Future studies could investigate whether such a cognitive mechanism may be involved in positive mental imagery generation inducing concurrent positive and negative mood amplification in individuals on the bipolar spectrum. Further, as mixed states have been associated with mood state switch in clinical samples (Niitsu, Fabbri, & Serretti, 2015; Perlis et al., 2010), an interesting question is whether concurrent positive and negative mood amplification by positive imagery could play a role in subclinical inter-episodic mood instability (Strejilevich et al., 2013) in the bipolar spectrum.

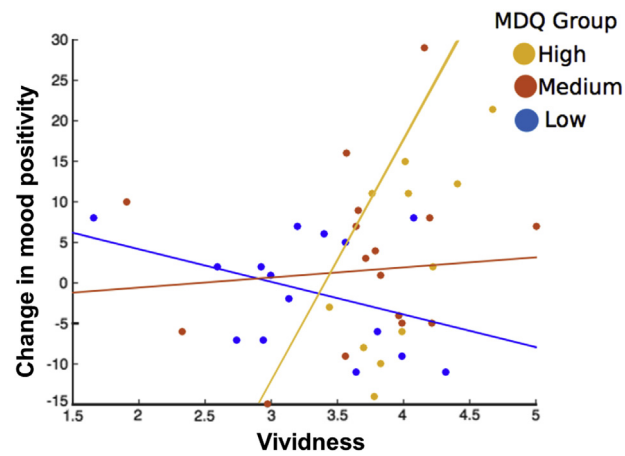

Fig. 3 – Imagery vividness and change in mood positivity over the imagery generation task by low, medium and high MDQ score groups. For participants high in hypomanic-like experiences (i.e., high but not medium or low MDQ groups), positive mood amplification was significantly moderated by vividness of mental images generated during the task – specifically, higher imagery vividness was associated with greater amplification in mood positivity in individuals scoring highly on self-reported hypomanic-like experiences.

Relevance to previous findings and suggestions for future work. In previous research, low vividness of imagery has been associated with low mood and depression (Holmes, Lang, Mould, & Steel, 2008; Morina, Deeprose, Holmes, Pusowski, & Schmid, 2011). The current study suggests that not only is there an association between depressive and manic mood

states and imagery vividness, but that in fact, the level of vividness may play a causal, moderating role in the direction of mood amplification. It is possible that in participants within the bipolar spectrum the positive imagery training generated an activated state, but this activation was perceived as exclusively positive mood amplification only in those able to experience very vivid positive imagery. More research is needed to evaluate this relationship and which aspects may qualify its role in bipolar spectrum symptomatology.

A limitation in our findings is that post-hoc and exploratory analysis were not corrected for multiple comparisons. As this was the first study investigating the direct impact of imagery generation and its vividness on mood change in relation to hypomanic-like experiences, replication is needed. Future studies should look more in depth into imagery vividness as moderator of mood amplification across psychopathologies. Emotionally neutral or negative imagery generation conditions could be helpful for investigating task effects on directional mood amplification. This could help tease apart whether vividness, no matter the experimental task, amplifies positive mood in hypomania, or whether vividness amplifies mood in the direction of the experimental mood manipulation. Emotional control conditions with a reduced imagery component, such as emotional verbal elaboration or mood induction conditions, could shed light on the extent to which mental imagery might have a causal role in the current findings. Note, however, that the finding that imagery vividness moderated the effect of task lends support to the notion that imagery specifically (rather than general mood effects) underlies the current findings. Our data also suggest that at subclinically relevant levels of hypomanic-like experiences, the relationship between imagery and mood change may be complex. In future studies, individual differences in vividness could be explored further using objective mental imagery measures (e.g., Bergmann, Genç, Kohler, Singer, & Pearson, 2016; Cui, Jeter, Yang, Montague, & Eagleman, 2007).

To generalize results to understanding BD, affect measures and diagnostic interviews were used. High comorbidity between individuals in our sample with high levels of hypomanic-like experiences and anxiety, co-occurring mental disorders, and substance use disorders, mimics profiles of individuals in BD samples (Bizzarri et al., 2007; Malik et al., 2014; Merikangas et al., 2011; Stratford, Cooper, Di Simplicio, Blackwell, & Holmes, 2015). Therefore, this lends weight to the generalizability of the current findings and their relevance to understanding the role of mental imagery in mood amplification across the bipolar spectrum (subclinical and clinical; Goodwin & Consensus Group of the British Association for Psychopharmacology, 2016). Assessing emotional mental imagery could improve psychopathological assessment and treatment in addition to current routine clinical practice in psychiatry and psychology (Di Simplicio, McInerney, Goodwin, Attenburrow, & Holmes, 2012; Pearson et al., 2015). Further studies could also explore generalizability in younger subclinical populations (i.e., adolescents) where mood instability is a common prodrome to psychopathology but remains poorly understood, and in clinical groups to allow translation into novel treatments.

If replicated, the current findings may have implications for psychological treatments. Specifically, imagery-based interventions taking into account individual differences in imagery ability (vividness) could be useful in treatment of individuals on the bipolar spectrum. Targeting mental imagery in cognitive therapy is not a new concept, but is largely underused (Holmes et al., 2011). Beck's original conception of cognitive therapy emphasized the importance of targeting patients' imagery as well as verbal thoughts (Beck, 1976). Within BD, verbal cognitions have been targeted with only limited success (Geddes & Miklowitz, 2013). Mental imagery targeted therapies have been effective in other psychopathologies such as social anxiety and PTSD (Clark et al., 2006; Ehlers, Clark, Hackmann, McManus, & Fennell, 2005), and a recent case series study has shown that they can reduce mood instability in BD (Holmes, Blackwell et al., 2016; Holmes, Bonsall et al., 2016; Hales et al., under review). Certain components of mental imagery may be particularly useful targets for intervention. In the current study, positive imagery generation was identified as a possible instigator of mood amplification in the bipolar spectrum, with imagery vividness playing a role in the nature of mood amplification in individuals high in hypomanic-like experiences.

5. Conclusion

To conclude, following a positive mental imagery generation task, the current study shows evidence for a relationship between hypomanic-like experiences and mood amplification, providing partial support for the mental imagery emotional amplifier hypothesis (Holmes, Geddes et al., 2008; Holmes et al., 2010). Furthermore, this is the first experimental study to identify mental imagery vividness as a possible moderator of valence-congruent mood amplification in individuals high in hypomanic-like experiences. Tentatively, these results suggest the positive imagery generation task amplified positive mood in individuals high in hypomanic-like experiences, in a manner that was dependent on their individual imagery ability. This provides the first experimental evidence that mental imagery may act as a positive (manic) mood amplifier in the bipolar spectrum, with potential implications for identifying at risk groups and developing targeted therapies (Goodwin & Consensus Group of the British Association for Psychopharmacology, 2016). Further advances could be achieved if non-clinical research on mental imagery from other domains could be brought to bear on improving treatments for psychopathology (Pearson et al., 2015).

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Declaration of interests

The Authors have no declaration of interests to report.

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