**Relationship between creativity and depression: the role of reappraisal and rumination**

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# Abstract

Previous research has found mixed evidence about whether increased creativity is associated with higher depression. We investigated the relationship between creativity and depression, and the role of two emotion regulation strategies: rumination and reappraisal. Previous research has found that rumination is a common factor that contributes to creativity and depression, which we attempted to replicate using a simplified model. No research has tested the relationship between reappraisal frequency and creativity. We hypothesized that controlling for reappraisal frequency could reduce the correlation between creativity and depression, or even reverse the relationship. To test the hypotheses, we measured creativity, self-reported rumination tendency and reappraisal frequency, and trait depression in an online survey of *N*=201 participants. We found a small overall negative association between creativity and depression. Further analysis found support for the hypothesis that self-reflective rumination is a common factor for creativity and depression. Rumination was associated with both creativity and depression, and there was no association between creativity and depression when self-reflective rumination was controlled. We found no association between reappraisal frequency and creativity, and no change to the relationship between creativity and depression when reappraisal frequency was controlled. Our results suggest that creativity and depression are only weakly associated, and that the emotional regulation strategy of self-reflective rumination, not reappraisal frequency, could account for the overall relation between creativity and depression.

*Keywords*: creativity, depression, reappraisal, rumination

# Introduction

There has been a long-standing belief that creativity and depression are related. This belief may have been inspired by the historical examples of great minds who suffered from depression, such as painter Edvard Munch, author Ernest Hemingway, poet Silvia Plath, and musical composer Tchaikovsky (Jamison, 1993, as cited in Greenwood, 2020). This idea may also be perpetuated by movie tropes or stereotypes of “tortured artists”, which suggest that extraordinary creative gifts come at a cost. Is the association between creativity and depression just a myth, or is it supported by scientific evidence?

Although many studies have investigated this question, the relationship between creativity and depression is not fully understood. There are theoretical reasons to expect that creativity might be either positively or negatively related to depression, as discussed later. Some studies have found evidence that higher creativity is associated with higher depression (e.g. Ludwig, 1992; MacCabe et al., 2018; Papworth et al., 2008; Taylor et al., 2017), while other studies failed to replicate a positive association using similar methods (e.g. Chermahini & Hommel, 2012; da Costa et al., 2015; Kyaga et al., 2013; Silvia & Kimbrel, 2010). The inconsistent findings have inspired research on possible mediating factors (Verhaeghen et al., 2005). In this study, we investigate the relationship between creativity and depression and the role of emotion regulation strategies.

## Creativity

Creativity is defined as the tendency to generate novel and functional ideas that are useful in problem-solving, communications, and entertainment (Franken, 1994).

Creativity is a multidisciplinary concept and researchers have approached it in different ways. For instance, Kaufman and Beghetto (2009) have proposed the Four C model (mini-c, little-c, Pro-c, Big-C), which divides creativity into four developmental levels of gradual expertise. Others have categorized creativity into domains (e.g. everyday, visual, verbal, performance, scientific etc.) (e.g. Taylor, 2017; Villanova & Cunha, 2020), creative achievements (e.g. Carson et al., 2005), creative professions (e.g. Ludwig, 1992), or creative activities (e.g. painting, writing, musical composition etc.) (e.g. Hocevar, 1980; Verhaeghen et al., 2005). It is also regarded as a relatively permanent and consistent dispositional trait that is linked to other stable attributes such as personality or intelligence (e.g. Feist, 1998; Puryear et al., 2017; Zhang et al., 2020).

One testable and reliable feature of creativity is divergent thinking. Divergent thinking is the thought process used to generate diverse and numerous ideas in a free-flowing manner (Razumnikova, 2012), in contrast to convergent thinking, which is to arrive at one single answer. Divergent thinking leads to originality (Kim, 2017; Runco & Acar, 2012), which is a central feature of creativity. Hence, divergent thinking abilities are indicative of creative thinking and creative potential (Cramond, 2020; Kim, 2017). In this study, we focus on divergent thinking as the primary measure of creativity.

Creativity is usually regarded as a strength and an advantageous trait, but studies have found it to be correlated with emotional instability and mental disorders (e.g. Ludwig, 1992; MacCabe et al., 2018; Papworth et al., 2008; Taylor et al., 2017). Hence, this study seeks to investigate and explain how creativity and depression are related.

## Creativity and depression – Evidence for positive relationship

Studies on the relationship between creativity and depression have reported mixed findings. A meta-analysis by Taylor et al. (2017) examined direct links between creativity and depression and found evidence that creative individuals exhibited more instances of mood disorders, including unipolar depression. This finding was also replicated by studies that only considered divergent thinking as the measure of creativity (e.g. Flood, 2006; Le et al., 2015; Sánchez et al., 2010). A systematic review by Holm-Hadulla et al. (2021) also found support for the positive association between creativity and depression, but it depended on the severity of depression. The findings of Hadulla et al. (2021) suggest that mild-to-moderate levels of disorders can motivate creative work, which helps to overcome emotional crises, while more severe illnesses will only inhibit creativity. Other studies have not observed any systematic relationship between creativity and depression (e.g. Foster et al., 2011; Grigorenko & Sternberg, 2001; Silvia & Kimbrel, 2010; Zabelina et al., 2014). Thus, there remains uncertainty about the overall relationship between creativity and depression.

The use of different measures of divergent thinking could contribute to the mixed findings. Studies of creativity and depression have used a variety of creativity measures, including verbal tasks like the Similes Preference Inventory (Flood, 2006) and the Alternative Uses Tasks (Silvia & Kimbrel, 2010), and figural tasks such as Test for Creative Thinking-Drawing Production (Le et al., 2015) and Abbreviated Torrance Tests for Adults (Zabelina et al., 2014). If depression is related to certain aspects of creativity, the apparent relationship might depend on the measure. In this study, we use the Torrance Test of Creative Thinking because it is the most commonly used for creativity research.

In addition to mixed empirical evidence for a positive relationship between creativity and depression, there are theoretical reasons to expect a relationship in the opposite direction (e.g. Baas et al., 2008; Chermahini & Hommel, 2012). This is discussed in the next section.

## Creativity and depression – Negative relationship?

While the expectation based on stereotypes would be a positive association between creativity and depression, there are reasons to expect that creativity would be associated with lower depression. When the effect of depression on creativity is considered, the expectation would be lower creativity with greater depression. In the other direction, creativity is associated with some traits that are known to protect against depression, and creative activities can help to reduce depression. These observations seem to conflict with the empirical findings of a positive relationship between creativity and depression.

Becoming depressed would not generally lead to enhanced creativity, and instead would be expected to inhibit creativity. Depressed individuals often experience anhedonia, a loss of interest and decreased energy, which inhibits creativity (Shapiro & Weisberg, 1999; as cited in Verhaeghen et al., 2005). Studies have shown that creativity is enhanced by positive affect and approach motivation, while sadness and depressed moods are deactivating moods and are not associated with creativity (Baas et al., 2008).

Creative individuals have traits that would be expected to reduce depression. Some studies have found that creativity is associated with higher emotional intelligence, as indicated by low alexithymia and high empathy (da Costa et al., 2015; Xu et al., 2019). Emotional intelligence entails the ability to perceive, express, regulate and reason with emotions (Mayer & Salovey, 1997). Studies show that emotional intelligence is associated negatively with depression and positively with a better overall mental wellness (Kousha et al., 2018). This suggests that creative people, who are found to have higher emotional intelligence, can better understand and manage negative emotions, leading to a more positive emotional outcome. Creative people have also been found to have better reappraisal ability, which is an emotional regulation strategy associated with lower depression (Troy et al., 2010; Weber et al., 2014).

Another reason is that creative people would be expected to have less depression is that creative activities have been shown to have therapeutic effects (Leckey, 2010). These activities include painting, making handicrafts, writing a journal, playing a musical instrument, drama performance and so on. Studies showed that taking part in creative activities as a leisure or a hobby acts as a buffer against depression (Israel et al., 2020). It was also suggested that creative activities can unlock access to the flow experience, which is linked to an improved mental well-being (Chilton, 2013). These findings have established practical implications for art therapy theories and mental health interventions. Research has also indicated that the divergent thinking elements within a creative thinking task can induce systematic mood swings, leading to a more positive mood, as opposed to depressed emotions (Chermahini & Hommel, 2012).

 If creativity is associated with greater tendency toward depression despite these advantages, it would suggest that the relationship is due to some other factor that is related to depression. In the next section, we discuss self-reflective rumination as a potential mediator.

## Emotion regulation strategy: Rumination

Self-reflective rumination has been found to be a common trait for people who are creative and people suffering from depression (Verhaeghen et al., 2005). Rumination usually involves repetitive thoughts about the past and present, causes and consequences, which results in and maintains negative moods (Sansone & Sansone, 2012; Smith & Alloy, 2010). Rumination is a hallmark symptom of depression (Alderman et al., 2015) and is generally considered as a maladaptive emotion regulation strategy (ERS; Aldao et al., 2010). However, rumination could also be recognized as a style of thought that is repetitive and perseverative, detached from its negative contents and affect (Nolen-Hoeksema et al., 1993). Nolen-Hoeksema et al. (2008) proposed that this underlying style of thinking, with features of introspection, pondering, and an analytical assessment of problems, has commonalities with the adaptive strategy of self-reflection - the genuine curiosity about the self (Verhaeghen et al., 2005). Therefore, self-reflection can be considered as an adaptive type of rumination, which is defined as the recurrent thoughts that focus on the self, inner memories, and feelings (Verhaeghen et al., 2014).

Verhaeghen et al. (2005) found that self-reflective rumination is a confounding factor that explains the link between creativity and depression. They found no direct relations between creativity and depression, instead reporting that self-reflection independently increases the risk for depression and boosts creative interests and abilities simultaneously. The relation between self-reflective rumination and depression is due to self-directed attention or self-focus, which was found to induce negative moods (Mor & Winquist, 2002, as cited in Verhaeghen et al., 2005). Self-reflective rumination is also associated with creativity as people who reflect upon their lives frequently tend to be more motivated to seek creative outlets to share their emotions and use their negative moods as information to inspire new ideas (Watkins & Mason, 2002, as cited in Verhaeghen et al., 2005).

However, the influence of self-reflective rumination was established within a complex path model involving the relationships between the past and current depression, self-reflective rumination, divergent thinking, creative interests, and creative behavior (Verhaeghen et al., 2005). In an attempt to simplify the model, we only tested divergent thinking as a measure of creativity, self-reflective rumination, and trait depression. We hypothesized that the association between creativity and depression will decrease when self-reflective rumination is controlled. This could provide a clearer and more direct understanding of how self-reflective rumination is related to creativity and depression.

## Emotion regulation strategy: Reappraisal

Reappraisal is another emotion regulation strategy (ERS) found to be associated with creativity (e.g. Fancourt et al., 2019; Orkibi et al., 2021; Perchtold-Stefan et al., 2021; Wu et al., 2017). Reappraisal (or cognitive reappraisal) is the cognitive change that involves altering our perceptions and reinterpreting a situation to reduce the negative impacts (Gross, 2002). For example, if you received a bad grade on a course, the immediate reaction could be to fixate on the failure and feel frustrated. But, with reappraisal, one may look on the bright side, such as thinking that at least you did not fail, or find a silver lining, such as how this experience gave you a deeper understanding of your strengths and weaknesses. Reappraisal is regarded as an adaptive ERS. It is found that people who use reappraisals more often tend to have more positive emotions and an overall improvement in psychological health (Megías-Robles et al., 2019).

Researchers have distinguished the two facets of reappraisal: ability and frequency (Southward et al., 2021; Troy et al., 2010). Reappraisal ability is the ability to generate reinterpretations that are effective in changing mood. For example, in response to the negative thought of "I'm worthless", a low-quality reappraisal would be "I'm not worthless" (Southward et al., 2021). By contrast, a more effective reappraisal would be more elaborated and contextualized, such as "Every person, including me, is inherently worthwhile. I'm also a committed partner who works hard at my job and cares for people in my community" (Southward et al., 2021). As for reappraisal frequency, it represents the habitual use of reappraisal in daily life (Liu & Thompson, 2017; Weber et al., 2014). The ability and frequency of reappraisal are found to be independent and unrelated to each other (Troy et al., 2010; Weber et al., 2014). Hence, the two factors may affect depression differently.

## Reappraisal and depression

Reappraisal ability has been found to be negatively associated with depression. It was found that people with higher reappraisal ability exhibited fewer depressive symptoms (Troy et al., 2010). Southward et al. (2021) also found that among people with low levels of depression, reappraisal ability can cause significant affective change, while reappraisal frequency has little effect. In their experiment, participants who had lower depressive symptoms reported that they experienced a greater decrease in negative affect due to the quality of the reappraisals, regardless of how frequently they used reappraisal in their daily lives (Southward et al., 2021).

Similarly, reappraisal frequency is also found to be negatively associated with depression. Many studies have demonstrated a strong relation between reappraisal frequency and depression (e.g. Joormann & Gotlib, 2010; Megías-Robles et al., 2019). According to Southward et al. (2021), although reappraisal ability can cause significant mood change in people at low levels of depression, reappraisal frequency is more important than reappraisal ability for inducing mood change for people with high levels of depression. Studies also showed that depressed people have significantly lower reappraisal frequency than people at lower levels or without depression (Aldao et al., 2010; Southward et al., 2021). Still, Liu and Thompson (2017) found that when instructed to implement cognitive reappraisals to regulate happy and sad emotions, their reappraisals are as effective as non-depressed controls (Liu & Thompson, 2017). This shows that although depressed people may use reappraisal less frequently, they may not lack reappraisal ability. The underutilization of reappraisals could be due to low self-efficacy beliefs and the self-perception of low reappraisal ability, which is not representative of their actual ability (Dryman & Heimberg, 2018; Liu & Thompson, 2017).

## Creativity and reappraisal

Reappraisal ability is found to be strongly linked to creativity through divergent thinking. People who are highly creative are found to have higher divergent thinking abilities (Runco & Acar, 2012), which allows them to come up with novel reappraisals that effectively reassess a bad situation from multiple perspectives. This is because the process of generating novel reappraisals is similar to that of generating ideas during creative thinking. The measures for reappraisal ability (e.g. Reappraisal Generation tasks, Reappraisal Inventiveness Test, or the Script-based Reappraisal Test) were also developed based on divergent thinking theories and activities, and it was found that the scores of a creative thinking test can predict reappraisal ability (Wu et al., 2017). Neuroscientific studies have also found supporting evidence: when observed under an EEG or an fMRI, reappraisals involve the same cognitive processes and activates the same brain region as generating verbal creative ideas (Fink et al., 2017; Perchtold et al., 2018), which are the same verbal tasks used in the current study. Furthermore, research has found that the more creative the reappraisal is, the more effective it is in alleviating discomfort (Wu et al., 2017). These findings suggest a strong association between creativity and reappraisal ability.

Nonetheless, there appears to be a paradox regarding how reappraisal, creativity, and depression are related to one another. There is evidence that creative people tend to have higher reappraisal ability, and that higher reappraisal ability is associated with less depression. Based on these findings, higher creativity should be associated with lower depression (a negative association). However, this inference contradicts the studies that show creativity being associated with greater depression (a positive association). No studies have reported lower depression among creative people compared to non-creative individuals, as might be expected based on their reported better reappraisal ability.

One possible explanation is that other factors counteract the potentially beneficial effect of higher reappraisal ability among creative individuals - namely, the effect of reappraisal frequency. Reappraisal frequency is believed to be independent of reappraisal ability (Weber et al., 2014), so it may be associated with creativity in a different way. No studies have investigated the relationship between creativity and reappraisal frequency. Based on this missing link, as well as the mixed evidence regarding the association between creativity and depression, we hypothesized that reappraisal frequency may have a suppressing effect on these variables, which could change the relationship between creativity and depression. It is possible that even though creative people are skilled in reappraisals, they might not access this ability habitually, which increases depressive tendencies. In this case, when we control for reappraisal frequency, a negative relation between creativity and depression could emerge. Alternatively, it is also possible that there is no systematic relationship between creativity and reappraisal frequency - perhaps creative people do not differ in the use of reappraisal frequency compared to non-creative people. In this case, the relationship between creativity and depression remains unchanged when reappraisal frequency is introduced.

## Gender and emotion regulation strategies

If the relationship between creativity and depression is mediated by ERSs, it could be different depending on gender. There is some evidence that the effects of ERSs on depression are moderated by gender. Several studies have found that women tend to ruminate more than men, which accounted for greater depression in women (Johnson & Whisman, 2013; Krause et al., 2018; Nolen-Hoeksema, 2012). Preston et al. (2022) found a similar moderating effect for reappraisal frequency: women reported greater use of reappraisal compared to men, which was negatively related to depressive symptoms only for women. However, other studies investigating the effects of ERSs failed to find moderation by gender (Masumoto et al., 2016; Perchtold et al., 2019; Trives et al., 2016). Given these inconsistent findings, it is unclear whether gender would be expected to moderate the relationship between creativity and depression.

## The present study

The current study investigates how ERSs could explain the connection between creativity and depression. Specifically, we examined how creativity is associated with the normal variations of depression in the general population through the use of rumination and reappraisal.

First, our study addressed the basic question of (1) whether there is an overall positive association between creativity and depression.

Second, we added self-reflective rumination to our present model of creativity and depression. Based on the findings by Verhaeghen et al. (2005), they showed that self-reflective rumination is a confounding variable while there no direct relation is detected between creativity and depression. We hypothesized that (2) when self-reflective rumination is controlled, the positive association between creativity and depression will be reduced.

Third, we hypothesized that reappraisal frequency could influence the relation between creativity and depression. We added reappraisal frequency to our model as a suppressor for the relationship of creativity and depression. We predicted that (3) when reappraisal frequency is controlled, the positive association between creativity and depression will be reduced further or even become negative.

In addition to testing these main hypotheses, we also tested whether gender moderates the relationship between ERFs and depression, and between creativity and depression.

# Methods

## Open science statement

The research plan was preregistered on OSF prior to data collection: osf.io/yub7n. The study was submitted as a registered report to Peer-Community-In and received in-principle acceptance in October 2022. The Stage 1 registered report manuscript that received in-principle acceptance is available here: osf.io/n3xrm. There were no deviations from the preregistered plan. Data and materials are available at: osf.io/fczpd.

## Participants

A total of 224 participants were recruited through Amazon’s Mechanical Turk (MTurk) service. However, we excluded the data from 23 participants because they did not follow instructions or complete the task. Specific reasons for exclusion include failure to complete all sections (20 participants) and failure to follow instructions on attention check items (3 participants). The data from the remaining 201 participants were used for analysis.

 Because our aim was to evaluate normal variations of depression in the general population, we did not select based on previous experience with depression. Subjects varied from reporting no previous experience with depression to reporting severe depressive symptoms. We excluded people who have experience with Torrance Tests of Creative Thinking or any other creativity thinking tests, because prior experience with these tasks could improve their performance and increase their overall scores. Subjects with diagnoses of bipolar disorders and schizophrenia were also excluded, because these diagnoses are associated with the component of mania or positive symptoms, such as delusions and hallucinations, which are found to be associated with enhanced creativity (e.g. MacCabe, 2018; Power et al., 2015; Silvia & Kimbrel, 2010) and also higher depressive symptoms (Bosanac & Castle, 2013; McCormick et al., 2015; Stamouli, 2010; Upthegrove et al., 2017). The filtering process was done prior to data collection and we made sure that all requirements are met before participants respond to our survey.

The target sample size was *N* = 200. This was the largest sample size that was feasible given funding and time constraints, and would be enough to detect small-to-medium correlations. The sample size provides 80% power to detect small effects of r>.19 and 95% power to detect medium effects of *r*>.25. Smaller effects could not be reliably detected, but trends could be used as the basis for further study. The width of the 95% confidence intervals for correlation estimates would range from .28 for small correlations (*r*<.2) to .21 for a medium correlation (*r*=.5). This would provide some information even if effects are too small to detect.

We conducted a pilot experiment with a convenience sample of *N*=122 using the same measures and procedure. The pilot data and analyses are available at https://osf.io/fczpd/. The pilot experiment found a small-to-moderate overall correlation between creativity and depression (*r* = .212, CI [.035,.376]), a strong overall correlation between rumination and depression (*r* = .614, CI [.489,.713]), and trend toward a small-to-moderate correlation between creativity and rumination (*r* = .175, CI [-.003,.342]). These results are generally consistent with the findings of Verhaeghen et al. (2005), who reported a correlation of *r* = .24 between self-reflective rumination and depression, and a correlation of *r* = .09-.35 between rumination and creativity measures (including fluency, originality, elaboration) in a large path model. Based on the pilot results and previous findings, our sample size of *N*=200 would have good power to detect relationships between creativity, rumination and depression.

However, our sample size may not be enough to reliably detect the relationship between reappraisal frequency and the other measures. Our pilot experiment found only a weak correlation between reappraisal frequency and creativity (*r* = .108, CI [-.071,.280]), and between reappraisal frequency and depression (*r* = ‑.088, CI [-.261,.092]). No previous studies have directly investigated the relationship between creativity and reappraisal frequency, but there have been studies of the relationship between reappraisal frequency and depression. A meta-analysis by Aldao et al. (2010) found evidence for a small-to-moderate correlation between reappraisal frequency and depression. The correlations observed in individual studies ranged from *r* = ‑.14 to -.29 and the overall correlation estimated across studies was *r* = ‑.17. The findings of Aldao et al. (2010) suggest that the relationship between reappraisal frequency and depression may be stronger than observed in our pilot experiment, but the expected correlations would still be relatively small relative to our sample size of *N*=200.

## Materials

The task and measures used in this study are described below. The full questions and scales are available at https://osf.io/fczpd/.

### Creativity

To measure creativity, we used a subset of four tasks selected from the verbal subscale of the Torrance Tests of Creative Thinking (TTCT; Torrance, 1966). TTCT measures creativity by using a set of open-ended idea-generation tasks, which engages divergent thinking abilities. TTCT is the most widely used creative test and has been regarded as the gold standard of creativity measure (Cramond, 2020). There are two modalities, TTCT-figural that requires mostly drawing responses and TTCT-verbal that elicits written or oral responses. Although studies have found that TTCT-figural to be a more comprehensive, reliable, and valid measure of creativity than TTCT-verbal (Kim, 2017), no online platforms offer a reliable solution to collect drawing responses, hence only the TTCT-verbal was chosen.

For each task, participants were asked to generate as many ideas as possible in under 2 minutes. An example of a task is “try to think of many different possible uses for a brick” (see Appendix B for the full questionnaire). Participants could not proceed to the next task until the 2 minutes had elapsed. The standard TTCT uses a 3 min response period per trial. We used a shorter duration because we were collecting data through an online platform, and we were concerned that a longer duration would deter people from participating.

The responses were manually screened to make sure that participants were performing the task as instructed. If responses were irrelevant to the instructions on any trials, the data from that subject was excluded.

Responses were rated on fluency (the number of ideas), flexibility (the number of categories), and originality (the number of novel ideas). Fluency is scored by counting the number of answers. Flexibility is scored by counting the number of categories. Originality is scored by counting how many times an answer is duplicated among other participants, which suggests that the answer is not original. To obtain the originality raw score, this number is inverted using 1/n. The sum of the three sub scores forms the creativity total score. There is little subjectivity in scoring and TTCT is largely reliable (Runco & Acar, 2012).

One rater scored the TTCT according to the guidelines on the TTCT interpretive manual (Torrance, 2018). Interrater reliability was assessed by having a second rater independently scored a subset of 30 responses. The intraclass correlation coefficient (ICC) across the items was 0.932, indicating excellent reliability in scoring.

 To prepare the TTCT data for analysis, the ratings on fluency, flexibility, and originality were added up to form a total creativity score, which was converted to a standard score with a mean of 100. According to the Interpretive Manual (Torrance, 2018), the frequency distribution usually captures a range of total scores from <50 to 150+. The total scores were used in the main analyses for our hypotheses, while the sub-scores of fluency, flexibility, and originality were used in the exploratory analysis.

### Rumination

Rumination tendency was measured using the 22-item Rumination Responsiveness Scale (RRS; Nolen-Hoeksema & Morrow, 1991). ​​The RRS is a self-report measure that assesses the habitual tendency of rumination (see Appendix D for the full questionnaire). It is a commonly used measure in rumination research (Cohen & Ferrari, 2010). It includes 5 items measuring brooding, 5 items measuring self-reflection, while the rest are depression-related. Subjects rated how often they experienced different rumination tendencies on a 4-point scale (1 = almost never, 4 = almost always). An example of an item is "How often do you think about how alone you feel?". As only self-reflective rumination was found to be related to creativity (Verhaeghen et al., 2014), only the five items about self-reflection were analyzed, and the total scores were calculated by the average of sums of each Likert point, which range from 1 to 4.

### Reappraisal Frequency

Reappraisal frequency was assessed using the 10-item Emotion Regulation Questionnaire (ERQ; Gross & John, 2003). ERQ is a self-report that questionnaire assesses the emotional experience – how they feel on the inside, as well as behavioural expression – how they show their emotions through their behaviours and communication (Gross, 2002). Six items measure cognitive reappraisal while four items measure expressive suppression. Participants were asked to rate the statements on a 7-point scale (1 = strongly disagree, 7 = strongly agree; see Appendix C for the full questionnaire). An example of a Likert statement is “When I want to feel more positive emotion (such as joy or amusement), I change what I’m thinking about.” Only the six items on the reappraisal subscale were analyzed, and the total scores were calculated by the average of sums of each Likert point, which range from 1 to 7.

### Depression

We chose to measure trait depression instead of state depression, in contrast to some other studies (e.g. Baas et al., 2008; Perchtold et al., 2019; Verhaeghen et al., 2005). The rationale is that creativity is theorized to be a stable dispositional trait rather than a temporary state (e.g. Feist, 1998; Puryear et al., 2017; Zhang et al., 2020). If creative individuals have greater tendency toward depression, it would be revealed in trait depression as both variables are relatively permanent and consistent. Measuring trait depression also allows us to assess the normal variations of depression in the general population.

Trait susceptibility to depression was measured using the 18-item Maryland Trait and State Depression – Trait Scale (MTSD-T; Chiapelli et al., 2014). It is a self-report that measures the severity of depressive symptoms in their adult lives according to the diagnostic symptoms of DSM-V (see Appendix E for the full questionnaire). Participants were asked to indicate how often they generally feel in most of their adult life (in your whole life since age 12), excluding the past one week, on a 5-point scale (0 = never, 4 = experienced many times in a month for almost every month of my adult life). An example of a Likert statement is “It has been hard for me to feel happy throughout my life.” Each point on the Likert scale will add up to form a total score that ranges from 0 to 72.

### Data Quality Check

Since responses are collected through an online survey rather than a controlled environment, attention check questions were added to each questionnaire section to ensure participants’ paid attention to the study instructions. An example of an attention check “This is an attention check. Please select “strongly disagree” for this question.” There was one attention check question per questionnaire (RRS, ERQ, and MTSD-T respectively). Subjects who failed to answer them according to instructions were excluded in the analysis.

## Procedure

Participants completed an online questionnaire via MTurk and Qualtrics which took about 15 minutes. They first completed a timed creative thinking test with four questions and 2 minutes per question. Then, they answered questions about how they usually react to emotional situations and their emotional states. Participants were guaranteed anonymity (see Appendix A for the informed consent form). After completion of the questionnaires, each participant received 2.5 USD as financial compensation. The present study was approved by the Departmental Research Ethics Committee, Department of Psychology at The University of Hong Kong.

## Analysis Plan

### Creativity & Depression

To test the overall relationship between creativity and depression (see Hypothesis 1), we planned to perform a linear regression using creativity as the independent variable and depression as the dependent variable.

### Self-reflective Rumination

To test whether differences in self-reflective rumination contribute to the overall relationship between creativity and depression (see Hypothesis 2), we planned to perform a multiple regression analysis using both creativity and rumination as independent variables and depression as the dependent variable. If an overall correlation between creativity and depression was found in the initial analysis, we planned to conduct an additional mediation analysis to test whether there was a significant indirect effect of creativity on depression that is mediated by rumination. We planned to use the bootstrapping method (10000 samples) for the mediation analysis.

### Reappraisal frequency

To test whether reappraisal frequency acts as a suppressing variable for the relationship between creativity and depression (see Hypothesis 3), we planned to perform a multiple regression analysis using depression as the dependent variable and three predictors: creativity, rumination, and reappraisal frequency. If the mediation analysis for rumination and creativity finds a significant indirect effect on depression, we planned to repeat the analysis using reappraisal frequency as an additional control variable.

### Exploratory analysis – Creativity dimensions

If creativity was found to be associated with depression, reappraisal, or rumination, we planned additional analyses computing the correlation of these measures with three separate measures of creativity: fluency, flexibility, originality.

### Exploratory analysis – Moderation by gender

We planned to perform three additional regression analyses to test whether gender moderates the relationship between: rumination and depression, reappraisal frequency and depression, and creativity and depression.

### Inference criteria

We used the standard *p*<.05 criteria to determine statistical significance.

# Results

## Descriptive Statistics

Descriptive statistics of participants are shown in Table 2. Total creativity scores ranged from 61 to 141 (*M* = 100, *SD* = 15.0). Depression scores ranged from 0 to 64 (*M* = 19.4, *SD* = 17.1). Self-reflective rumination scores ranged from 1.25 to 5.00 (*M* = 2.53, *SD* = 0.900), and reappraisal frequency scores ranged from 0.857 to 6.00 (*M* = 4.52, *SD* = 1.04).

***Table 2***

*Descriptive Statistics of Participants*

|  |  |  |
| --- | --- | --- |
|  | *N* | *%* |
| Gender |  |  |
| Male | 115 | 57.2% |
| Female | 84 | 41.8% |
| Other/ Prefer not to say | 2 | 1.0% |
| Age |  |  |
| 18-24 | 7 | 3.5% |
| 25-34 | 67 | 33.3% |
| 35-44 | 65 | 32.3% |
| 45-54 | 38 | 18.9% |
| Over 55 | 24 | 11.9% |
| Race/ Ethnicity |  |  |
| White | 140 | 69.7% |
| Hispanic or Latino | 13 | 6.5% |
| Asian | 16 | 8.0% |
| Black or African American | 23 | 11.4% |
| Native Hawaiian or Other Pacific Islander | 2 | 1.0% |
| Mixed Ethnicity | 7 | 3.5% |
| Occupation |  |  |
| Architecture and engineering | 5 | 2.5% |
| Arts, culture and entertainment  | 11 | 5.5% |
| Business management and financial services  | 31 | 15.4% |
| Community and social services  | 5 | 2.5% |
| Education  | 10 | 5.0% |
| Science and technology | 42 | 20.9% |
| Sports and fitness | 0 | 0% |
| Installation, repair and maintenance  | 4 | 2.0% |
| Industrial manufacturing  | 12 | 6.0% |
| Farming, fishing and forestry | 2 | 1.0% |
| Food preparation and serving | 7 | 3.5% |
| Government administration and law enforcement | 1 | 0.5% |
| Health and medicine | 16 | 8.0% |
| Legal and public policy  | 2 | 1.0% |
| Sales | 26 | 12.9% |
| Other: responses include self-employed, logistics, data entry, real estates, unemployed etc. | 27 | 13.4% |

## Creativity and Depression

To test the overall relationship between creativity and depression (see Hypothesis 1), we performed a linear regression using creativity score as the predictor (IV) and the MTSD-T depression score as the dependent measure (DV). We found that overall creativity significantly and negatively predicts depressive symptoms, *R2* = .0277, β = ‑.166, *F*(1,199) = 5.67, *p* <.05. This does not support our hypothesis that creativity and depression are positively associated, instead it shows a negative association between the two.

## Self-reflective Rumination

To test self-reflective rumination as a common factor for creativity and depression (see Hypothesis 2), we added self-reflective rumination (IV) to our previous regression model consisting of creativity (IV) and depression (DV) and observed how the relationship between creativity and depression changed when self-reflective rumination is controlled.

The results of the regression indicated the two predictors explained a significant proportion of the variance, *R2* = .366, *F*(2, 198) = 57.2, *p* <.001. Results also show that creativity did not significantly predict depression (β = ‑.0375, *p* = .519) when rumination is controlled. Compared with the previous analysis, the beta coefficient between creativity and depression remained negative but decreased when self-reflective rumination was added to the model, which supports our hypothesis. Results also show that self-reflective rumination significantly and positively predicted depression (β = .5959, *p* <.001). Regression results are shown on Table 3.

***Table 3***

*Regression results after introducing self-reflective rumination into the model*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Predictor | *B* | SE | *t* | β | 95% Confidence Interval | *p* |
| Lower | Upper |
| Intercept | -4.9485 | 7.7557 | -0.638 |  |  |  | 0.524 |
| Creativity | -0.0427 | 0.0660 | -0.647 | -0.0375 | -0.152 | 0.0768 | 0.519 |
| Self-reflective rumination | 11.3104 | 1.1001 | 10.282 | 0.5959 | 0.482 | 0.7102 | < .001 |

*Note. F*(2, 198) = 57.2, *p* <.001, *R2*=.366

To test the direct and indirect effects of creativity on depression, we also performed a mediation analysis with rumination as a mediating factor. We used a bootstrapping method with 10000 samples and used creativity as the IV, depression as the DV, and self-reflective rumination as the mediator. Figure 1 shows the path analysis results for creativity, self-reflective rumination, and depression. Results showed a significant indirect effect among the three variables in the expected direction (β = ‑.129, *SE* = .0504, *p <*.05). There was a significant negative association between creativity and self-reflective rumination (β = ‑.217, *SE* = .00435, *p <*.05). There was also a strong and significant positive association between self-reflective rumination and depression (β = .596, *SE* = 1.199, *p <*.001). The direct effect between creativity and depression was not significant (β = ‑.0375, *SE* = .0652, *p* = .513). The total effect of the model was significant (β = ‑.167, *SE* = .0794, *p <*.05). The results are consistent with the possibility that self-reflective rumination contributed to the small negative correlation between creativity and depression. Rumination was associated with both creativity and depression with a significant indirect link, and there was no significant direct effect of creativity on depression when rumination was controlled.

Our results support our hypothesis about the role of rumination. Contrary to expectations, the overall correlation between creativity and depression was negative rather than positive. However, consistent with our hypothesis, we found evidence that rumination is associated with both creativity and depression, and could account for the small overall correlation observed in our experiment.

***Figure 1***

*Path model of self-reflective rumination as the common factor for creativity and depression*

Creativity

Depression

-.167\*

*c*

Self-reflective rumination

Creativity

Depression

-.217\*\*

.596\*\*\*

-.0375

*Indirect* = -.129\*\*

*a*

*b*

*c’*

*Note.* \* *p <*.05, \*\* *p <*.01, \*\*\* *p <*.001

## Reappraisal Frequency

To test how reappraisal frequency is related to creativity and depression (see Hypothesis 3), we used the same approach as the rumination analysis. We added reappraisal frequency (IV) to our existing multiple regression model consisting of creativity (IV), self-reflective rumination (IV), and depression (DV) from our previous analyses.

 When reappraisal frequency is controlled, there was little change in the qualitative results. The overall model explained a significant proportion of the variance, *R2* = .401, *F*(3,197) = 44.0, *p* <.001. As before, self-reflective rumination significantly and positively predicted depression (β = .6082, *p <*.001), and creativity did not significantly predict depression (β = ‑.0488, *p* = .389). Reappraisal frequency significantly and negatively predicted depression (β = ‑.1888, *p <*.001). Regression results are shown on Table 4.

***Table 4***

*Regression results after introducing reappraisal frequency into the model*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Predictor | *B* | SE | *t* | β | 95% Confidence Interval | *p* |
| Lower | Upper |
| Intercept | 9.8344 | 8.7114 | 1.129 |  |  |  | 0.260 |
| Creativity | -0.0556 | 0.0644 | -0.863 | -0.0488 | -0.160 | 0.0627 | 0.389 |
| Self-reflective rumination | 11.5446 | 1.0739 | 10.750 | 0.6082 | 0.497  | 0.7198  | < .001 |
| Reappraisal frequency | -3.1162 | 0.9140  | -3.409 | -0.1888  | -0.298 | -0.0796  | <.001 |

*Note. F*(3, 197) = 44.0, *p* <.001, *R2*=.401

To further explore the relations among the variables of creativity, depression, and reappraisal frequency, we computed the pairwise correlations among these variables. The correlation matrix is presented in Table 5. We found no detectable correlation between creativity and reappraisal frequency, *r*(199) = ‑0.074, *p* = .296, and there was a trend toward a negative correlation between reappraisal frequency and depression, *r*(199) = ‑.138, *p* = .051.

Our results do not support our hypothesis that reappraisal frequency influences the overall relationship between creativity and depression.

***Table 5***

*Correlations among Creativity, Reappraisal frequency, and Depression*

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | 1 | 2 | 3 |
| 1. Creativity | – |  |  |
| 2. Reappraisal frequency | -0.074 | – |  |
| 3. Depression | -0.166\* | -0.138 | – |

*Note.* \* *p <*.05, \*\* *p <*.01, \*\*\* *p <*.001

## Exploratory analysis: Creativity dimensions

We conducted an exploratory analysis regarding separate measures of creativity: fluency, flexibility, originality, and examined whether specific aspects of creativity are more related to the emotional regulation strategies or to depression.

We computed a correlation matrix using the raw scores of fluency (*M* = 26.5, *SD* = 9.14), flexibility (*M* = 20.1, *SD* = 5.76), originality (*M* = 24.6, *SD* = 7.37), reappraisal frequency, self-reflective rumination, and depression. Results are shown on Table 6. As expected, the three creativity factors were strongly related to each other. Depression was negatively correlated with both flexibility, *r*(199) = ‑.177, *p <*.05, and originality, *r*(199) = ‑0.193, *p <*.05, and there was a trend toward a negative correlation between depression and fluency, *r*(199) = ‑.111, *p* = .118. All three creativity factors were negatively correlated with self-reflective rumination: fluency, *r*(199) = ‑.170, *p <*.05, flexibility, *r*(199) = ‑.193, *p <*.05, and originality, *r*(199) = ‑.152, *p <*.05. Overall, the findings from analyses of individual creativity factors were consistent with the relationships observed between the total creativity score and other variables.

***Table 6***

*Correlations with creativity measures*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variables | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. Fluency | – |  |  |  |  |  |
| 2. Flexibility | 0.898\*\*\* | – |  |  |  |  |
| 3. Originality | 0.733\*\*\* | 0.786\*\*\* | – |  |  |  |
| 4. Self-reflective rumination | -0.170\* | -0.193\*\* | -0.152\* | – |  |  |
| 5. Reappraisal frequency | -0.095 | -0.119 | -0.068 | 0.087 | – |  |
| 6. Depression | -0.111 | -0.177\* | -0.193\*\* | 0.589\*\*\* | -0.101 | – |

*Note.* \* *p <*.05, \*\* *p <*.01, \*\*\* *p <*.001

## Exploratory analysis: Gender

We performed additional exploratory analyses to test whether gender moderates the relationships between emotion regulation strategies and depression. For each IV (rumination and reappraisal), we performed a multiple regression analysis with depression as the DV, and gender as a moderator of the IV.

Most of the subjects indicated their gender as "male" or "female", so our analyses used these two genders. We omitted 2 subjects who indicated their gender as “other/ prefer not to say”. The remaining 199 subjects were used for the analyses of gender.

To test whether gender moderates the relationship between self-reflective rumination and depression, we performed a regression analysis using rumination (IV), gender (moderator), and depression (DV). We found no significant interaction between gender and rumination on depression (β = ‑.169, *p* = .148). Depressive symptoms increased with self-rumination for both males (β = .661, *p* = <.001) and females (β = .492, *p* = <.001), and there was no significant difference in the strength of the association.

We used the same approach for reappraisal frequency (IV), gender (moderator), and depression (DV). We found no significant interaction between gender and reappraisal frequency (β = ‑.227, *p* = .123). When results from females and males were analyzed separately, we found a significant negative relationship between reappraisal frequency and depression for females (β = ‑.2541, *p <*.05), but not for males (β = ‑.0268, *p* = .764). However, this trend toward interaction was not significant.

# Discussion

## Overall relationship between creativity and depression

Contrary to our hypothesis that there would be an overall positive association between creativity and depression, we observed a small but statistically significant negative association between creativity and depression. The negative association is consistent with results from some previous studies that found that higher creativity is associated with positive moods (Chermahini and Hommel , 2012; Baas et al., 2008), and inconsistent with results from a number of other studies that observed an association between high creativity and depressed emotions (see Introduction).

Because we measured trait depression and recruited from the general population, the range of depression reported by subjects was relatively low. Out of possible range of [0,72], the mean depression score was 19.4 with standard deviation of 17.1. The low levels are not surprising given that trait depression asks about depressed experiences during one's lifetime, and most people tend to be quite emotionally balanced throughout their life (Chiapelli et al., 2014). In contrast, many of the previous studies of creativity and depression measured state depression (e.g. Baas et al., 2008; Papworth et al., 2008; Verhaeghen et al., 2005), which would be expected to show more fluctuations and a wider range. It is possible that a sample that includes people with a wider range of depression, or more severe depression, would show a different overall relationship between creativity and depression.

Our finding provides evidence against the idea that the relationship between creativity and depression is an inverted u-shaped function, which has been proposed by some researchers to explain inconsistent findings (Holm-Hadulla et al., 2021; Richards et al., 1988, as cited in Taylor, 2017). An inverted u-shaped function predicts that a sample with low levels of depression would show the strongest positive association between creativity and depression, whereas we observed a small negative association.

## Self-reflective Rumination

Although we did not find the predicted positive relationship between creativity and depression, our results provide support for the hypothesis that the association between creativity and depression is mediated by self-reflective rumination. We found that rumination was correlated with both creativity and depression, and there was no detectable association between creativity and depression when rumination was controlled. A mediation analysis also found a significant indirect effect of creativity on depression through rumination.

Our findings are mostly consistent with the results reported by Verhaeghen et al. (2005). They found no direct relation between creativity and depression, and instead found that self-reflective rumination is associated with creativity and depression independently. We similarly found no direct relation between creativity and depression and independent associations with rumination. However, we found a negative association between creativity and rumination, whereas Verhaeghen et al. (2005) observed positive associations between creativity measures and rumination. Apart from this difference, our results are consistent with those of Verhaeghen et al. (2005).

Our finding of a strong association between self-reflective rumination and depression is generally consistent with previous findings. A number of studies have demonstrated that self-reflective rumination increases depressive symptoms (Eikey et al., 2021; Takano & Tanno, 2009; Treynor et al., 2003). However, studies that investigated state depression found only a small relation with self-reflective rumination (e.g. Treynor et al., 2003; Verhaeghen et al., 2014). We measured trait depression and found a stronger association with self-reflective rumination (β = .60). This suggests that the habit of self-reflective rumination could contribute to a chronic tendency toward depression, even if the short-term association between rumination and state depression is weak. Further research could investigate how rumination affects depressive symptoms in the long-term (trait depression) versus the short-term (state depression).

## Reappraisal frequency

Our results did not support our hypothesis that reappraisal frequency contributes to the relationships between creativity and depression. We hypothesized that creative people might have decreased reappraisal frequency, which could counteract the potential benefit from their better reappraisal ability. Contrary to this hypothesis, we found no evidence for a correlation between creativity and reappraisal frequency, and controlling for reappraisal frequency had no detectable effect on the association between creativity and depression. Our study found a negative association between creativity and depression regardless of whether reappraisal frequency was controlled.

This study is the first to test the relationship between creativity and reappraisal frequency. Many studies have reported a positive relationship between creativity and reappraisal ability (e.g., Runco & Acar, 2012; Wu et al., 2017). However, reappraisal ability need not be associated with reappraisal frequency (Southward et al., 2021; Troy et al., 2010). Our results suggest that creative and non-creative people use reappraisal at similar rates.

The correlation between reappraisal frequency and depression observed in our study is weaker than would be expected based on previous research. Reappraisal is known to be an effective emotion regulation strategy, and previous studies have observed a strong negative relationship between reappraisal frequency and depression (e.g. Joormann & Gotlib, 2010; Megías-Robles et al., 2019). We found that reappraisal frequency was a significant negative predictor of depression when rumination was controlled, but the association was weak (β = ‑.189). The weak relation could be due to the low rates of depression in our sample. Southward et al. (2021) reported that increased reappraisal frequency did not cause significant affective change to people with low depression, whereas increased reappraisal ability did cause changes in mood. Because our sample showed mostly low depression, the results of Southward et al (2021) predict that reappraisal frequency would not be strongly associated with depression, and that reappraisal ability might have had a stronger association. An improvement for future studies would be to measure both the reappraisal ability and the reappraisal frequency for a sample with a wider range of depression.

## Exploratory analysis: Creativity measures

To explore whether certain aspects of divergent thinking are more related to rumination, reappraisal, or depression, we performed correlation analyses using the three subcomponents of the divergent thinking measure (fluency, flexibility, and originality).

We found that the three measures were related to other variables in a similar way. All three variables showed strong positive correlations with both depression and self-reflective rumination, and none showed a significant correlation reappraisal frequency. Thus, our findings would be qualitatively the same if we had used one of the three creativity measures rather than an overall measure of creativity that combines these measures.

We also found that the fluency, flexibility, and originality measures were highly correlated with each other. This is consistent with previous findings (Akgül & Kahveci, 2016; Alabbasi et al., 2021; Vartanian et al., 2020), and not surprising given the nature of the TTCT. When a person generates more answers (high in fluency), their answers will naturally tend to include a larger number of different categories (high in flexibility), and have more ideas that are considered novel (high in originality). Because the three measures were strongly correlated, our data do not provide a good test of whether fluency, flexibility or originality drives the observed correlations with depression and rumination.

## Exploratory analysis: Gender

We found no evidence that gender moderated the relationship between rumination tendency and trait depression. This is contrary to some previous findings that rumination and depression are more strongly associated for women than for men (Krause et al., 2018; Nolen-Hoeksema, 2012). A possible explanation could be the type of rumination measured in our study. We only measured the self-reflective aspects of rumination, whereas the studies by Nolen-Hoeksema (2012) and Krause et al. (2018) took brooding and depression-related factors into account.

We also failed to detect a moderating effect of gender on the relationship between reappraisal frequency and depression. However, there was a trend toward a gender interaction in the same direction reported by Preston et al. (2022). Consistent with Preston et al. (2022), we found a significant association between reappraisal frequency and depression for women but not for men. Our failure to detect the moderation effect reported by Preston et al. could have been due to lower power, as they used a much larger sample (N=906) than in our study (N=199).

The results of our exploratory analyses suggest that gender had little influence on the relationships between creativity and emotion regulation strategies.

## Online data collection

Use of an online questionnaire for data collection presents some limitations.

The depression scale in our study was adapted from a scale that was not designed to be self-administered. It is recommended that the MTSD-T should be treated like a formal clinical interview and be administered in a “self-rating under clinical interview environment” format to minimize distractions (Chiapelli et al., 2014).

We also adapted the standard protocol of the Torrance Tests of Creative Thinking (TTCT) to better suit an online platform. For instance, we controlled the overall test time by selecting 4 tasks only and each task was shortened from the standard 3-minute to 2 minutes. The collected responses show a few instances where answers were cut off, presumably because the time was up. The TTCT interpretive manual has also advised that raters should also receive proper training to ensure reliability in scoring (Torrance, 2018). Despite these deviations from the proper administration of TTCT, we still observed normal variations in creativity and a high interrater reliability, suggesting that the results remain valid.

## Comparison to pilot results

We conducted a pilot study with a substantial sample using the same task and measures, which can be compared to the present results. The pilot data and analyses are available on the OSF repository for this study.

The overall correlation between creativity and depression observed in the present study is in the opposite direction of the correlation observed in our pilot study, suggesting that this finding may not be robust. The pilot study used a convenience sample of N=122 participants from Hong Kong and observed a small positive correlation (*r* = .212), whereas the present study used N=201 participants recruited from MTurk and observed a small negative correlation (*r* = –.167). Given the conflicting findings from our studies, we are not confident that an overall negative correlation would be consistently observed across different populations.

However, the present study and pilot study observed consistent findings concerning the role of self-reflective rumination. In both studies, rumination was strongly correlated with trait depression and there was no detectable association between creativity and depression when rumination was controlled. In the present study, creativity was negatively associated with rumination, and a mediation analysis found a small but significant negative indirect effect of creativity on depression. In the pilot study, there was a trend toward a positive correlation between creativity and rumination, and a corresponding trend toward a positive indirect relationship between creativity and depression. Thus, rumination could account for the results from both studies. For whatever reason, the association between creativity and rumination were in opposite directions in the present study and the pilot study. If rumination mediated the relationship between creativity and depression, the different associations between creativity and rumination would result in different overall associations between creativity and depression, as observed in our studies.

## Conclusion

Contrary to the idea that creativity is associated with tendency toward depression, we observed an overall negative association between creativity and trait depression. However, the overall association was weak, and we found no direct association between creativity and depression when self-reflective rumination was controlled. Given the weak association observed here and the conflicting findings in the literature, we speculate that creativity and depression do not have a consistent overall relationship in the general population.

Our findings support the idea that self-reflective rumination could cause an indirect association between creativity and depression. Consistent with many previous studies, we observed a strong association between rumination and depression. Our mediation analysis found that this relationship could account for the observed association between creativity and depression. This finding is consistent with the findings of Verhaeghen et al. (2005) except for the sign of the association between creativity measures and rumination. If other studies of creativity and depression tested populations that had different associations between creativity and rumination, this could account for some conflicting findings.

Our study is the first to test for an association between creativity and reappraisal frequency. We found no evidence for an association, and controlling for reappraisal frequency had little or no effect on the observed relationship between creativity and depression. Although creative people have been found to have better reappraisal ability, our results suggest that they use reappraisal at similar frequency as people who are less creative.

# Conflict of interest disclosure

The authors of this article declare that they have no financial conflict of interest with the content of this article.

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| ***Table 1 - Research plan and outcomes*** |  |  |
| **Question** | Is increased creativity associated with higher depression? | Does the relationship between creativity and depression change when self-reflective rumination is controlled?  | Does the relationship between creativity and depression change when reappraisal frequency is controlled? |
| **Hypothesis** | (1) Creativity is positively associated with depression. | (2) When self-reflective rumination is controlled, the positive association between creativity and depression will be reduced.  | (3) When reappraisal frequency is controlled, the positive association between creativity and depression will be reduced or even become negative.  |
| **Sampling plan** | We chose a sample size of N = 200 based on funding and time constraints. This sample size would have 80% power to detect small to medium effects of r>.19, and 95% power to detect medium effects of r>.25. The sample size would be able detect small to medium effect sizes, or report trends that could be used as the basis for further study. The width of the 95% confidence intervals for correlation estimates would range from.28 for small correlations (r<.2) to .21 for medium correlations (r=.5). This would provide some information even if effects are too small to detect. |
| **Analysis Plan** | We will perform a linear regression analysis, with creativity as the independent variable (IV) and depression scores as the dependent variable (DV).  | We will perform a linear regression analysis, with creativity (IV), self-reflective rumination (IV) and depression (DV). If an overall correlation between creativity and depression was found in the initial analysis, we will conduct an additional mediation analysis to test whether there was a significant indirect effect of creativity on depression that is mediated by rumination. We will use the bootstrapping method (10000 samples) for the mediation analysis. | We will perform a linear regression analysis, with creativity (IV), self-reflective rumination (IV), reappraisal frequency (IV) and depression (DV).If the mediation analysis for rumination and creativity finds a significant indirect effect on depression, we will repeat the analysis using reappraisal frequency as an additional control variable. |

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| **Hypothesis** | (1) Creativity is positively associated with depression. | (2) When self-reflective rumination is controlled, the positive association between creativity and depression will be reduced.  | (3) When reappraisal frequency is controlled, the positive association between creativity and depression will be reduced or even become negative.  |
| **Rationale for sensitivity** | Our pilot study (N=122) using the same measures found an overall correlation between creativity and depression of of r = .212. Our target sample size of N=200 provides 85% power to detect an effect with r = .212.  | Our pilot study found correlations of r = .641 between rumination and depression and r = .175 between creativity and rumination. Verhaeghen et al (2005) reported a correlation of r=.24 between rumination and depression, and correlations between rumination and creativity measures ranging from r = .09-.35. Our target sample size of N=200 provides 95% power to detect an effect of r>.25, and over 80% power to detect an effects of r >.19. | Based on previous studies, a small-to-moderate relationship between reappraisal frequency and depression would be expected (Aldao et al., 2010). However, our pilot study found only weak correlations between reappraisal frequency and creativity (r = .108) or depression (r = ‑.088). Our target sample size would not be enough to reliably detect these small associations, but the results would constrain the size of possible effect to a CI with width .28.  |

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| **Hypothesis** | (1) Creativity is positively associated with depression. | (2) When self-reflective rumination is controlled, the positive association between creativity and depression will be reduced.  | (3) When reappraisal frequency is controlled, the positive association between creativity and depression will be reduced or even become negative.  |
| **Interpretation given different outcomes** | We will follow the standard NHST to interpret the significance of our results.Creativity may or may not have an overall association with depression. If p>.05, we will compute the Bayesian inferential tests using creativity (IV) and depression (DV). We will report the Bayes factor and the 95% CIs of the estimated posteriors for the effects. This will provide some information about the strength of evidence if we observe non-significant trends. | We will follow the standard NHST criteria to observe whether the overall relationship between creativity and depression is positively associated when self-reflective rumination is introduced.We will also observe if the association between creativity and depression is reduced when self-reflective rumination is controlled, compared to the analysis with just creativity and depression in our first hypothesis.We will also present the path model and report the indirect, direct, and total effects of a mediation analysis.If p>.05, we will follow the same approach and compute the Bayes factor and 95% CIs using creativity (IV), self-reflective rumination (IV) and depression (DV).  | We will follow the same approach as rumination: use the standard NHST and observe how the relationship of creativity and depression has changed when reappraisal frequency is introduced to our model. We will observe whether the association creativity and depression is reduced when both reappraisal frequency and rumination are controlled. We hypothesize that the association may even become negative when reappraisal frequency is added.We will also follow the same approach as rumination if the mediation analysis is performed: present the path model and report the indirect, direct, and total effects of the analysis.If p>.05, we will use the same approach and compute the Bayes factor and 95% CIs using creativity (IV), self-reflective rumination (IV), reappraisal frequency (IV) and depression (DV).  |

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| **Hypothesis** | (1) Creativity is positively associated with depression. | (2) When self-reflective rumination is controlled, the positive association between creativity and depression will be reduced. | (3) When reappraisal frequency is controlled, the positive association between creativity and depression will be reduced or become negative. |
| **Theory that could be shown wrong by the outcomes** | Previous findings have been mixed. The results from this study could support previous findings that creativity is linked to depression or could support previous findings that there is no overall association. | Verhaeghen et al. (2005; 2014) measured state depression instead of trait depression, and used different measures of creativity. If the expected relations are not observed, it could be due to these differences in measures. | No previous studies have investigated the relation between creativity and reappraisal frequency. It is possible that reappraisal frequency is unrelated to creativity, such that when reappraisal frequency is controlled, the overall association between creativity and depression remains unchanged. This would inform us that the reappraisal frequency is not masking a negative relationship between creativity and depression. |
| **Research outcomes** | Hypothesis was disconfirmed. We found a small overall negative association between creativity and depression | Hypothesis was confirmed. Our analysis showed that self-reflective rumination is a common factor for creativity and depression. Rumination was associated with both creativity and depression, and there was no association between creativity and depression when self-reflective rumination was controlled. | Hypothesis was disconfirmed. We found no association between reappraisal frequency and creativity, and no change to the relationship between creativity and depression when reappraisal frequency was controlled. |